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Abstract

This study was concerned with the collection and analysis of empirical data regarding the public and private costs and some utility aspects of vocational-technical education at two educational centers. Activities included establishing: (1) occupational objectives of programs offered, (2) the degree of attainment of occupational objectives by graduates in terms of earnings levels, (3) a cost-effectiveness ratio, by dividing the private and public costs per student by a ranked utility number assigned to the earnings level of each sampled graduate and computing a mean ratio for each program, and (4) a simulation model with respect to optimizing a number of interacting variables such as staff and facility organization and utilization. The study report is preceded by a literature review and discussions of cost-utility as an emerging concept, the cost-benefit role in Planning, Programming, and Budgeting Systems (PPBS), and cost-utility systems in school administration. A model for further analysis is presented following the study report. (JK)

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Final Report
Project No. 569–124
From October 14, 1968 to June 30, 1969

COST EFFECTIVENESS

Analysis of Vocational-Technical Education Programs

Department of Educational Administration
Educational Systems and Planning Center
The Florida State University
Tallahassee, Florida 32306

RICHARD H. P. KRAFT

The project reported herein was conducted pursuant to a grant from the Division of Vocational, Technical and Adult Education, Florida State Department of Education. Contractors undertaking such projects are encouraged to express freely their professional judgements in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent the official position or policy of the Florida State Department of Education.

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PREFACE

Educational administrators are continually called upon to make intelligent recommendations and decisions regarding efficiency in the operation of educational programs. As the demands of technology increase, Florida will require expanded vocational-technical education programs and it is apparent that present educational accounting and budgeting systems do not provide adequately organized information on educational program costs or on program effectiveness.

In the initial stages of this research project it seemed to be clear that there was no great shortage of theoretical analysis in the field of cost-benefit and cost-effectiveness analysis, but that relevant empirical material was practically non-existent. Moreover, the available published data was, more often than not, highly aggregative and excluded many economic variables. The result is that, in the past, it has been impossible to test numerical hypotheses at the level of the school, and much material on "education and occupation" has been of little use to the vocational-technical administrator because he has been unable to relate it to phenomena in which he is involved.

It is hoped that this report will provide a useful conceptual tool for use by educational program planners to project program requirements and evaluate alternatives with respect to resources and utility factors.

The study was carried out in the Educational Systems and Planning Center at The Florida State University. Dr. Richard H. P. Kraft planned and supervised the survey and prepared the report.

In this brief Preface only a few persons of the many involved can be mentioned. Among these are: Dr. Frank W. Banghart who assisted in the preparation of much of the material included;

two graduate students, Mrs. Susan Padro and Mr. Ned Lovell, whose time and talent went toward compiling material and who wrote parts of Chapter VI and III, respectively; Mr. Henry F. Raichle, who assumed the major responsibility of data collection, and who also contributed significantly to the statistical analysis; Mr. Hiram Green, graduate student, who assisted in the collection of data; and Miss Wilma Smith who performed the extensive secretarial work connected with this survey.

Finally, the author is very much in debt to the staffs of the area vocational-technical schools who welcomed him and gave him access to their records. Because of a need to preserve their identity, their names will not be mentioned, yet, without their cooperation, this report, and similar research and resulting improvements in vocational-technical education, become impossible.

Dr. Richard H.P. Kraft

July 1969

Cost-effectiveness analysis may look like a purely rational approach to decision-making, a coldly objective, scientific method free of the human attribute of preconceived ideas and partisan bias and judgment and intuition.

It isn't, really. Human judgment is used in designing the analysis; in deciding what alternatives to consider, what factors are relevant, what the interrelations between these factors are, and what numerical values to choose; and in analyzing and interpreting the results of the analysis. This fact--that judgment and intuition permeate all analysis--should be remembered when we examine the results that come, with apparent high precision, from analysis.

E. S. Quade

INTRODUCTION

During the last few years the relationship between the national education system and the national economy has attracted considerable public attention. While much of this attention has been focused on the economic arguments for increased public investment in education, there has been relatively little research on the actual effectiveness of the educational system and the relationships between the costs and utility of its various programs.

Cost-effectiveness analysis is the process by which costs and certain benefits associated with program outputs are related and studied by the decision-maker in the determination of priorities and the allocation of resources. Data is collected for this analysis in many ways, two of these being the traditional cost-analysis procedures and the use of modern quantitative analysis techniques.

The process of cost-effectiveness can and should be approached from two directions, the long view and the wide view. The long view is concerned with a longitudinal study covering a certain time period or number of time periods in the future that will assist in pointing out and preparing for possible future conditions and needs. The wide view is horizontal in nature and attempts to pinpoint side-effects, spillover, and any other non-direct influences and/or developments that may be derived from the project/system under analysis.

The very complementary nature of the benefits derived from the fulfilling of the various educational goals make them conceptually more difficult to measure than measurement of costs. Adding to the above problem is the fact that benefits spill over to third parties, often in an immeasurable form, making allocation of costs a difficult task indeed. Education has both investment (in human capital) and consumption aspects that must be dealt with and it is difficult to separate these two aspects for precise measurements and quantification.

Certain indices of benefit, measured in terms of economic efficiency goals, seem to be the educational benefits that are easiest to isolate. Indices developed for socialization goal measurement are less easily dealt with, although, to some extent, one can measure and quantify such social indices as voting behavior, crime rate change, and general knowledge of current events.

One of the problems found in obtaining good cost data is that empirical data indicate variations because of size of school population, hours of instruction, quality of equipment and materials. These factors must be more controlled if valid cost-benefit information is to be derived.[1]

Much of the educational cost-benefit work has been concentrated upon the costs of education, especially earnings foregone and potential higher incomes due to benefits derived from additional education. An investigation of this concentration on dollar amounts reveals this as a factor that has great influence upon cost-benefit studies. The main problem area is the obtaining of adequate, quantifiable data on facets of education other than costs. It is relatively easy to obtain the input costs to education, the tax share, the bonds sold, and contributions from the public and industry. Also, there is little difficulty in determining the short and long term financial returns to the studies as a result of certain amounts and types of education. The difficult measure is with personal and social outcomes, with affective domain development, and with benefits to society as a whole.

Criteria to be used by the educational decision-maker in cost-effectiveness analysis that are economic in nature would be: income of earning differentials and cost differentials, payback periods, cost-benefit ratios, expected capital values, and expected internal rate of return.[2] The ultimate criterion that the educational administrator could desire would maximize the difference between the present value of benefits and the present value of costs.

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[1] A. J. Corazzini, "When Should Vocational Training Begin?" (Madison, Wisconsin: Center for Studies in Vocational and Technical Education, University of Wisconsin, 1968.)

[2] M. Blaug, "An Economic Interpretation of the Private Demand for Education," Economics (May, 1966), p. 168.

One of the major problems within the Florida Public School System is estimating and projecting the capital and operational costs of educational programs. This problem is due, mainly, to the financial accounting and budgeting systems which are oriented to the fiscal appropriation structure for management control purposes rather than towards educational program accounting. Most school districts find it appropriate and necessary (by statute) to use organizational and object class categorizations (such as personnel services, maintenance, etc.) for a financial reporting and budgeting system.

In view of increasing student enrollments, increasing demands by employers for their occupational skills,[1] and the necessity of allocating scarce educational resources, several important questions are raised.

1. Do the existing vocational technical education programs provide positive cost utility relationships?

2. Can a cost-effectiveness analysis be used to develop optimum utilization models in terms of human resources (staff) and space facilities?

3. Can a cost-utility analysis be an effective technique for educational planners at local school system level to use as a conceptual tool to develop a planning, programming, budgeting system?

Taxpayers, school board members, and legislators, all of whom, essentially, are responsible for the financial support of public educational programs, are constantly faced with decisions concerning the allocation of scarce resources.[1] This cost-effectiveness study is expected to assist educational planners greatly in organizing evidence on which to base their choices among alternatives.

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[1] Richard H. P. Kraft, Education and Occupation (Tallahassee: Florida: Educational Systems Development Center, Florida State University, 1968).

Purpose of the Study

The purposes of this study are threefold: first, to examine the public and private costs and utility aspects of selected vocational-technical education programs; second, to yield formulae which will result in the development of a simulation model which can be used by educational administrators for planning optimum allocation of staff, facilities, finances, and other resources, and, third, to provide the basic conceptual tools for future implementation of a planning, programming, budgeting system (PPBS).

The study examines social and economic factors in the following areas:

1. the degree to which graduates of vocational-technical programs assume occupational earning levels in business and industry for which the objectives of the programs were designed;
2. the public economic costs per student of the programs;
3. the private costs to the students and their parents;
4. the cost-utility model as a conceptual tool for the design and implementation of a planning, programming, budgeting, system;
5. a simulation model for educational program planners and decision makers.

---

[1] It would be misleading to think that an educated labor force, being a productive capital resource, would have similar characteristics as monetary capital in the money market. There is no indication that the market mechanism for "human capital" will lead ever to optimal resource allocation in this field. It should be pointed out that economic analysis must fully consider the uniqueness of human capital if it is to assist federal government policy, or is to aid lower-level governments and private decision-makers to optimize the investment concept.

Statistical Design of the Study

This investigation is concerned with the collection and analysis of empirical data regarding the public and private costs and some utility aspects of vocational-technical education programs at two educational centers. The activities undertaken included:

1. A determination of the occupational objectives of vocational-technical education programs that are offered at the schools.
    a. This determination was made by: (1) personal interviews with supervisors, administrators, and instructors involved with each program; and, (2) a review of relevent brochures and catalogues.
2. A determination of the degree of attainment of occupational objectives by graduates of each program.
    a. This determination was made by: (1) collecting follow-up data on occupations and pay entry levels from student records of graduates; and, (2) assigning a ranked utility number (U) to the occupational earnings level of the graduate.
3. An economic cost-effectiveness ratio was determined for each program.
    a. This determination was made by: (1) computing the private and public costs per pupil of each program; and (2) using the utility number (U) determined in 2.a. above, compute a cost-utility ratio for each sampled graduate by:

$$\overline{CR} = \frac{C_p}{U}$$

$\overline{CR}$ = cost-utility ratio; C_p = cost of program; U = pay entry utility number. The mean cost-utility ratio was computed and compared for each ET program.

4. A simulation model was explored with respect to optimizing a number of interacting variables such as staff and facility organization and utilization.

Organization of the Report

The report is organized into seven chapters. Some of these are purely theoretical, some describe substantive conclusions, and some are concerned with the actual research procedures for this pilot project.

Chapters I and II are largely theoretical and are connected with the formulation of appropriate relationships and the clarification of a number of ideas on cost-effectiveness and cost-utility.

Chapter III deals with the methodology of school-level cost-effectiveness research and should give rise to many more fruitful hypotheses.

Chapter IV analyzes the role of cost-utility as a tool for school administrators and discusses various utility aspects.

Chapter V describes in detail the actual pilot study, and deals, in particular, with the numerous problems of data collection.

Chapter VI, then, is devoted to the question: Where do we go from here? The chapter examines a model for the development of more refined cost-utility analyses.

And, finally, Chapter VII lists a number of conclusions--empirical, theoretical, and methodological--which merited mention.

Concluding the report are a number of Appendixes dealing with such matters as: A. Investment Criteria in Education; B. Cost-effectiveness Analysis of Manpower Programs; and C. Cost-Effectiveness Glossary.

CHAPTER I

REVIEW OF RELATED LITERATURE

This chapter aims at reviewing the development of cost-effectiveness analysis approaches to program planning and evaluation. The review reflects that the relatively few attempts to apply cost-effectiveness analysis concepts to educational programs have been primarily concerned with evaluating outputs in relation to input and processing costs as a criterion for the decision to continue, expand, or discard the program under study. The emerging concept of "planning, programming, budgeting systems" (PPBS) as it applies to governmental and educational systems is also explored. In this chapter the use of cost-effectiveness analysis as a conceptual tool for the implementation of a planning, programming, budgeting system is discussed.

Definitions

"Systems analysis" is used as a broad term defining any orderly analytic study designed to help a decision maker identify a preferred course of action from among possible alternatives. As commonly used in the research community, the phrase "systems analysis" refers to a formal study intended to advise a decision maker on the policy choices involved in matters such as planning program objectives.[1]

A somewhat narrower definition is usually assigned to a cost-utility analysis. For example, each cost-utility analysis will involve, as one phase, a comparison of alternative courses of action in terms of their costs and utility aspects related to specific objective outputs. Usually the study consists of an attempt to minimize dollar cost subject to utility requirements or to maximize some measurable output subject to a budget constraint.[1]

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[1] E. S. Quade, Cost-Effectiveness Analysis: An Introduction and Overview (Santa Monica: RAND Corporation, 1965), p. 1.

Other related terms--"cost-benefit analysis" and "cost-effectiveness analysis"--depending on the context and user, imply some subtle distinction from a cost-utility analysis. Niskanen, for example, suggests that cost-benefit and cost-effectiveness studies are distinguished by their output measures.[2] He defines "benefits" as being measurable in monetary or market value which accrues at the margin of outputs, and "effectiveness" as an output which cannot be evaluated in monetary or market value units, as are many of the objectives in the humanities and social sciences educational programs.

However, for the purposes of this study, these terms are used synonymously and are assumed to be common in principle. Any differences found in the literature are to be considered matters of degree, emphasis, and context. The basic characteristics these analytic approaches seem to have in common include an effort to make comparisons systematically in quantitative terms, using a logical sequence of steps. To qualify as a complete analysis, Quade suggests that a study must look at the entire problem in its proper context.[3] Characteristically, such an analysis will involve a systematic investigation of the decision maker's objectives and of the relative criteria--costs, effectiveness, risks, and timing--associated with alternative strategies for achieving each objective.

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[1] _Ibid_., p. 2.

[2] W. A. Niskanen, "Measures of Effectiveness," in _Cost-Effectiveness Analysis_ ed. by T. A. Goldman, Washington Operations Research Council (New York: F. A. Praeger, 1967), p. 17.

[3] Quade, _op. cit_., p. 3.

Development of Cost-Utility Analysis Concepts

The need for considering cost in relation to utility and effectiveness must have occurred to the earliest planners. The more recent developments in cost-utility analysis theory have been concerned with the refinement of some of the earlier methods for relating cost to utility, and the acceptance of these methods as an aid to decision-making at high policy levels.

Cost-utility analysis is a relatively new development. The origin of its elements is found in general economic theory.[1] Grosse traces the birth of cost-effectiveness analysis as an analytic concept to the period shortly after (or during) World War II.[2] The names themselves are of more recent origin. There seems to be no record of the first use of the terms, but they are clearly derived from "cost-benefit analysis" which has been in use in business, industry, and government for several years prior to common use of the terms "cost-utility" and "cost-effectiveness."

According to Grosse, the widespread and rapid growth of interest in cost-effectiveness analysis dates from the appointment of Robert McNamara as Secretary of Defense, and subsequent developments in the Defense Department. With the appointment of Charles Hitch as Assistant Secretary of Defense, Comptroller, came the development of the program budgeting system--another conceptual element of a planning, programming, budgeting system. Hitch, former head of the Economics Division at the RAND Corporation, led a team of cost-effectiveness oriented analysts in the development of the program accounting-budgeting scheme.[3]

In the early 1960's, the application of cost-effectiveness analysis spread rapidly throughout the Defense Department, in defense oriented research and in defense contracting.

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[1] A. R. Prest and R. Turvey, "Cost-Benefit Analysis: A Survey," Economic Journal, LV (December, 1965), p. 683.

[2] R. N. Grosse, "Preface," in Cost-Effectiveness Analysis p. v.

[3] *Ibid.*, p. vi.

Capron makes note of a quote from the U. S. Bureau of Budget's "justification" of its fiscal year 1966 Budget before Congress:

> Program evaluation and cost effectiveness studies. In recent years there has been a considerable development, both inside and outside of Government, of improved methods of analysis that should be applied more intensively by the Bureau of Budget. Private industry as well as certain Federal agencies have found that systematic analysis, using recently developed techniques can facilitate vital analysis in such areas as examination of existing or proposed Federal programs for consistency, scrutiny of cost estimates, weighing the benefits from programs over extended periods of time, and the inclusion of risks and uncertainties in calculations of costs and benefits.[1]

Capron, interestingly, explains that the Bureau of Budget has not encouraged the use of the term "cost-effectiveness" in order to avoid giving "the impression that it [the Bureau] is primarily interested in developing more sophisticated tools of budget cutting."[2] He is quick to point out, however, that the economist does not equate efficiency with cutting back programs--though this interpretation is frequently encountered among the uninitiated. We suspect that this may be a reason for the relatively slow progress towards adoption and utilization of these concepts in education

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[1] W. M. Capron, "Cost-Effectiveness Analysis for Government Domestic Programs," in Cost-Effectiveness Analysis, p. 31.

[2] Ibid., p. 133.

Cost-Utility Studies Related to Education

Since the early 1960's developments have taken place that have had a significant impact on vocational-technical education. Federal expenditures for vocational and technical education were increased significantly from $56,920,000 in 1964 to $254,000,000 in 1968.[1] This sharp increase in funding mandated that evaluations of the impact of federal investments in people and educational programs be assigned a high priority.

Studies of the goals and objectives of vocational-technical education have been primarily concerned with verifying the appropriateness of existing objectives.[2] The most widely used procedures in these types of studies essentially utilize value judgements for rating the objectives in terms of their appropriateness to contemporary needs. These objectives usually are not stated in behavioral terms and, thus, are not subject to quantitative evaluation.

A number of studies have attempted to evaluate the effectiveness of vocational-technical education programs by analyzing the performance of graduates of the program. Sharp and Krasnegor summarized and analyzed forty-two follow-up studies in vocational-technical education. These authors indicated that a majority of these studies were descriptive in nature and, while these descriptive studies made valuable contributions to vocational-technical education, they suggest that much more attention be given to explanatory studies.[3] Their study also directs attention to the lack of follow-up information at the post-secondary school level for those trained in technical institutes and junior colleges.

---

[1] Advisory Council on Vocational Education, "Vocational Education: The Bridge Between Man and His Work," Notes and Working Papers Concerning the Administration of Programs (Washington, D.C.: Government Printing Office, 1968), p. 33.

[2] J. K. Coster and L. A. Ihnen, "Program Evaluation," Review of Educational Research, XXXVIII (Oct. 1968), p. 418.

[3] L. M. Sharp and R. Krasnegor, The Use of Follow-Up Studies in the Evaluation of Vocational Education (Washington, D.C.: Bureau of Social Science Research, 1966), Chap. I.

Empirical studies conducted on the economic impact of education in recent years have been concerned primarily with the determination of the effects of educational investments on growth of the economy and the rates of return, both private and social, to alternative levels of schooling.[1]

Carroll and Ihnen in a comparative study of forty-five high school and an equal number of ability-matched post-high school technical education graduates found that "social and private rates of return on investment in technical education were estimated at 16.5, and 22 per cent, respectively."[2] They concluded that while returns on individual technical education graduates were highly variable, 95 per cent received positive investment return.

In a cost-benefit study among four types of vocational-technical education programs, Corazzini found that annual salaries of graduates of vocational high schools were $82 to $560 higher than the salaries of regular high school graduates.[3] He argued, however, that the salary differences observed would decrease to zero in five to ten years based upon the assumption that vocational-technical training is primarily a substitute for on-the-job training. Coster and Ihnen were highly critical of this assumption and of his method of sampling graduates and estimating obtained earning data.[4]

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[1] Coster and Ihnen, op. cit., p. 418.

[2] A. B. Carroll and L. A. Ihnen, "Cost and Returns for Two Years of Postsecondary Technical Schooling," Journal of Political Economy, LXXV (Dec. 1967), p. 863.

[3] Corazzini, op. cit., p. 45.

[4] Coster and Ihnen, op. cit., p. 425.

Anderson studied direct costs in eight junior colleges and found substantial cost differences among curricula. His findings indicated that "a majority of the vocational-technical curricula offered in comprehensive junior colleges included in this study cost more per student than liberal art and transfer curricula in the same institutions."[1] Unit costs for curricula classified as industrial technical occupations were found to be 1.52 times more costly than unit costs for liberal arts and transfer programs.

A study by Luhmann postulates some of the basic principles underlying program cost accounting. While his study is limited to direct costing only, the author contributes a great deal toward solving one of the most basic problems of determining educational program operating costs--developing an account coding scheme for recording expenditures associated with an educational program.[2]

Williams, in a study of per pupil costs and outcomes of college students in Michigan, also developed instructional program costing rationale and bases for calculating costs.[3] Much of his rationale for assigning direct and indirect educational costs to courses and eventually to individual students is similar to the costing rationale used in this study. He also notes that variations and permutations of computing instructional costs within a given methodology are limited only by the number of individuals or institutions making such calculations. By inference, Williams warns researchers to beware of making invalid cost comparisons between educational programs for which separate studies were conducted by differing personnel.

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[1] E. F. Anderson, "Differential Costs of Curricula in Comprehensive Junior Colleges" (unpublished Doctoral dissertation, University of Illinois, 1966) (Abstract: Dissertation Abstracts 27: 3648-49A; No. 11, 1967).

[2] P. R. Luhmann, "Cost Accounting for Individual Student Programs" (unpublished Doctoral dissertation, University of Illinois, 1968), Chap. III.

[3] R. L. Williams, "Cost of Educating One College Student," Educational Record, XXIX (Oct. 1961), p. 324.

A number of valid precautions for those who base educational policy decisions on cost-utility analyses are offered by Williams. Included among these are:

1. Although costs of educating one student one year can be described in general terms by use of averages, one could not adequately understand the activities of an institution, or administer or support an institution by the use of such average costs alone.

2. There are so many variations in the factors affecting costs that comparisons of average costs, with implied meanings for efficiency of operation without consideration of quality, become of highly questionable value.

3. Statements of average costs of instruction are simple numerical descriptions of an operation. They may stimulate study of an instructional process but they should not control the process.

4. High costs in a given instructional area are not sufficient cause alone to abandon the educational program. Any curriculum with a small enrollment will have high unit costs...These facts do not alter the necessity for training people in urgently needed specialties...[1]

Another study useful to educators is one by David Sewell, research economist. In his study Sewell illuminates some of the difficulties and pitfalls encountered in measuring benefits accruing to the individual, society, and government. He stated that some authors consider studies which illustrate the improvement in the employment records of Manpower Development Training Act trainees by comparing their pre- and post-training status to be unsatisfactory. In his critique of published cost-benefit analyses Sewell cites the predominant reason given for this conclusion: "Employment, while important, may not be _the_ most important aspect of the trainee's experience. . . ."[1] Sewell's reply to this criticism is that _any_ gain may be important to the individual. He notes, however, that neither improvements in income nor employment exhaust the possible benefits that might result from these programs.

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[1] Ibid., p. 327-8.

Eckaus argues that studies of investment in education and returns are not necessarily reliable guides to policy formation.[2] Instead of these approaches, he suggests an alternative method which he feels would be useful to educational planners. His approach attempts to estimate directly the manpower requirements by vocational-technical skill categories and provide quantitative information needed for educational planning of "how much" and "what kind" of additional educational programs are required for growth. He states the steps to do this are: "(1) project future occupational levels, and (2) deduce from these the necessary educational [program] requirements."[3] It is this simple approach, using refined analytical techniques for estimation and projection, around which this study centers.

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[1] David O. Sewell, "A Critique of Cost-Benefit Analysis of Training," _Monthly Labor Review_, XXIX (September, 1967), p. 48.

[2] R. S. Eckaus, "Economic Criteria for Education and Training," _Review of Economics and Statistics_, (May, 1964), p. 183.

[3] _Ibid_., p. 190.

Benefit-Cost Analysis[1]

"Benefit-cost" analysis is by no means a new procedure. Haveman indicated that in 1936 Congress established benefit-cost analysis as a formal part of flood control project authorization.[2] The importance of the benefit-cost procedure in public finance is indirectly indicated by numerous publications of the United States Corps of Engineers and the Bureau of the Budget.

Chinitz and Tiebout defined benefit-cost analysis as simply another way of looking at decisions with respect to marginal changes.[3] They felt benefit-cost analysis was a tool of value in performance budgeting in the public sector, thus providing a measurement framework. They indicated that benefit-cost analysis has been utilized in two ways: (1) to determine the worth of planned projects, and (2) to determine the benefits which have accrued to a project previously initiated.

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[1] This material has been adopted from U.S., Department of Health, Education, and Welfare, Office of Education, Bureau of Research, An Economic Study of the Investment of Education in Agriculture (Washington, D.C.: Government Printing Office, April, 1968), pp. 15-20.

[2] Robert H. Haveman, Water Resource Investment and the Public Interest (Nashville: Vanderbilt University Press, 1965), p. 22.

[3] Benjamin Chinitz and Charles M. Tiebout, "The Role of Cost-Benefit Analysis in the Public Sector of Metropolitan Areas," in The Public Economy of Urban Communities, ed. by Julius Margolis. (Washington, D.C.: Resources for the Future, Inc., distributed by The Johns Hopkins Press, 1965), p. 252.

Davie defined the benefit-cost ratio as the ratio of the present value of future benefits to the present value of future costs.[1] From this definition the decision rules are obvious: (1) if the benefit-cost ratio for a program is less than one, the program should not be considered (with the exception of a program in which the intangible objectives cannot be adequately weighted in monetary terms); and (2) when comparing alternative programs, the higher ratio is associated with the more desirable program.

Davie reasoned that benefit-cost analysis is particularly applicable in the evaluation of public education expenditure programs due to the time element involved. He felt that the application of this procedure to individual students certainly was appropriate. Individual benefits would be the present value of future additional earnings after taxes.[2] The student would have two types of costs: direct and opportunity. The present value of individual program costs would be the benefit-cost ratio of the program for the student. The program with the highest ratio would be the logical choice provided the student goal was oriented toward economic return.

The benefit-cost formula for the individual participants in a one-year program was:[3]

$$B_j = \frac{\sum_{t=1}^{n} \frac{R_{tj}}{(1 + i_j)^t}}{O_j + C_j}$$

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[1] Bruce F. Davie "Using Benefit-Cost Analysis in Planning and Evaluating Vocational Education," a paper prepared for Davis S. Bushnell, Director, Division of Adult and Vocational Research, Bureau of Research, U. S. Office of Education, p. 7.

[2] Ibid., p. 8.

[3] Ibid., p. 16.

n = number of years over which additional income is expected.

R_{tj} = additional income net of taxes in year "t" expected by individual "j" to accrue as a result of completing a program of vocational education.

i_j = rate of interest used by individual "j" to discount expected future additional income.

O_j = opportunity costs as seen by individual "j".

C_j = direct costs of program to individual "j".[1]

Davie also suggested applying the benefit-cost analysis procedure to programs in vocational education in attempting to evaluate them from a societal point of view.[2] In this case, benefits would be the sum of the present value of future additional income accruing to all students over what their future income would have been had they not taken part in the program. He reasoned that taxes would not be subtracted from the additional returns because society benefits from this additional return.

Davie felt the major problem in "income determination" was determining what part of future gross income is, in fact, attributable to the training received. He suggested two procedures for isolating the additional income: (1) a simple experimental and control group analysis, and (2) development of a formal model to predict the additional income for a particular program.

Davie suggested that the rate of interest used in discounting benefits and costs in the societal analysis should be lower than that used by individuals. He found a rate of five or six per cent was currently acceptable--higher than government bonds but lower than corporation or individual rates of return.[1]

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[1] Ibid., p. 15

[2] Ibid., p. 8.

Davie discussed the cost determinations for the societal analysis in detail. He suggested simply eliminating most direct costs to the student in a society-supported program. He noted that individuals and society often attach different values to opportunity costs. The societal effect of an income foregone by an individual may be canceled due to the transfer of funds to another individual. In contrast, Davie stated that when individuals forego activity which is not income generating in the usual sense, such as housewifery or leisure, some societal estimate of the dollar value of such activity should have to be included in opportunity costs.[2] If the limited scope of the normal, local program involved is considered, it is apparent that Davie's statement is not in opposition to the concern about inclusion of opportunity costs in total cost figures. However, the question of opportunity costs is certainly open to debate.

Considering other societal costs, Davie emphasized that capital costs for additional items such as equipment and building space required by the new program must be considered. He also cautioned that normal operating costs such as salaries, supplies, and utilities must not be neglected. All costs are, of course, discounted to present value before the comparison is made with discounted benefits to determine the societal benefit-cost ratio for a program.

The benefit-cost formula presented for societal evaluation of a one-year program was:[3]

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[1] *Ibid.*, p. 9.

[2] *Ibid.*, p. 9.

[3] *Ibid.*, p. 19.

$$\overline{B} = \frac{\sum_{j=1}^{n} \sum_{t=1}^{n} \frac{\overline{R}_{tj}}{(1+\overline{I})^{t}}}{\sum_{j=1}^{n} \overline{O}_{j} + \sum^{n} C_{j} + \overline{C}_{t=0} + a_{\overline{I}p} K}$$

n = the number of program graduates each year.

$\overline{R}_{tj}$ = additional growth income in year "t" expected by society to accrue to individual "j" as a result of completing a program of vocational education.

$\overline{I}$ = rate of interest used by society to discount expected future additional income and costs.

$\overline{O}_j$ = opportunity costs for individual "j" as seen by society.

$\overline{C}_t$ = operating costs of a program in year "t" borne by society.

$a_{\overline{I}p}$ = annuity whose present value is 1, for interest rate $\overline{I}$ and number of years "p".

K - capital cost of a program borne by society.[1]

Davie presented an interesting variation of benefit-cost analysis.[2] His proposed variation has the benefits as the unknown in an equation which includes as the known (1) estimated costs of a particular program, (2) the number of students in the program or graduates, and (3) an arbitrarily selected benefit-cost ratio. He suggested that the pertinent question is:

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[1] *Ibid.*, p. 15.

[2] *Ibid.*, p. 10.

> What does the amount of benefits in terms of additional future income of students trained in the program have to be...so that the ratio of benefits to costs would at least equal the predetermined level.[1]

The investigator is told to compare the benefit in terms of average annual income to a reasonable estimate of the students' additional annual income as a result of the training.

A set of equations for the alternative method of benefit-cost analysis was presented:[2]

(1)

$$\hat{B} = \frac{X}{\bar{O}_o + C_o + \dfrac{\bar{C}_o + a_{\overline{ip}}\ K}{m}}$$

$\hat{B}$ = selected cut-off benefit-cost ratio

X = the present value of future additional income earned by the average program graduate.

o = average value.

(2)

$$Y = \frac{X}{A_{\overline{in}}}$$

---

[1] Ibid., p. 10.

[2] Ibid., p. 17.

Y = the average annual amount of additional future income which over "n" years would have a present value of "X".

$A_{\overline{i}n}$ = present value of an annuity for interest rate $\overline{i}$ and number of years "n".

Equation (1) is solved for X, and Y is determined using equation (2). The decision must then be made as to whether or not Y is a reasonable possibility.

Davie concluded his paper with the following list of general limitations to the use of the cost-benefit analysis:

(1) the failure of the procedure to deal with non-monetary returns;

(2) the problem of the comparative value of similar monetary sums for different people;

(3) the failure of the analysis to necessarily identify the best possible program;

(4) no adjustment for where the students will find employment.[1]

In a theoretical discussion of benefit-cost analysis, Hirshleifer, Dehaven and Milliman indicated that certain problems exist in the utilization of the benefit-cost ratio.[2] First, the intangible nature of many costs and benefits often does not permit the calculation of a ratio which is comparable to the unity rule. Second, the ratios of projects are comparable only if the cost elements are similar in scope.

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[1] *Ibid*., p. 13.

[2] Jack Hirshleifer, James C. Dehaven, and Jerome W. Milliman, *Water Supply Economics, Technology and Policy* (Chicago: The Rand Corporation, 1960), p. 137. See also the following part of this chapter: *Investment Criteria*.

They felt the best criterion was the maximization of the positive differences between the benefits and costs. The formula they recommend discounts the net benefits in a given time period, but yields the same results as the procedure which discounts benefits and costs separately.[1]

They warned that the major problem in the application of the benefit-cost ratio or difference analysis was the tendency to inflate benefits and make ultraconservative estimates of costs.

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[1] Ibid., p. 152.

CHAPTER II

COST-UTILITY: AN EMERGING CONCEPT

As the emphasis upon education as an investment in human resources has increased in recent years, so too has the attitude toward obtaining and allocating resources in order to optimize their utilization. During the past decade new uses regarding the budgetary process have come into existence. The trend is to view the budget as a dynamic, flexible instrument which maps out plans and encourages flexibility in a dynamic changing society. There is also a tendency toward more long range planning of the budgetary process. Because of the new emphasis on flexibility, long range planning is possible. That is, long range planning is considered to be a general blueprint rather than a rigidly structured plan.

The objectives of educational budgeting cover five major areas: analyzing, planning, controlling, monitoring, and evaluating for effectiveness. The budget document furnishes a primary source for analyzing various functions of the system. It furnishes a detailed breakdown regarding the allocation of resources and lends itself well to the procedures of cost budgeting. The budget has been referred to as a program document which allocated resources according to missions. According to Anshen this is in contrast to budget preparation in terms of item expenditures. "The main advantage claimed for the program budget is that it promises to do this more actively and more efficiently by (1) providing a framework for more clearly defined alternatives among which choices must be made, and (2) creating an information system that will assist in measuring cost in relation to accomplishments."[1]

Fisher has emphasized the relevance of systems analysis to the budget in reference to cost/utility analysis. Cost/utility analysis as envisioned here may be distinguished by the following major characteristics:

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[1] Melvin Anshen, "The Federal Government as an Instrument for Management and Analysis," Programmed Budgeting, ed. by David Novick. (Cambridge: Harvard University Press, 1965) p. 18.

(1) The fundamental characteristic is a systematic examination and comparison of alternative courses of action that might be taken to achieve specified objectives for some future time period.

(2) Critical examination of alternatives typically involves numerous considerations; but the two main ones are assessment of the costs (in the sense of economic resource costs) and the utility (the benefits or gains) pertaining to each of the alternatives being compared to obtain the stipulated objectives.

(3) The time contacts is the future (off from the distance future five, ten or more years).

(4) Because of the extended time horizon, the environment is one of uncertainty (very often a great uncertainty).

(5) Usually the context in which the analysis takes place is broad (often very broad) and the environment very complex with numerous interactions between the key variables and the problem.

(6) While quantitative methods of analysis should be used as much as possible because of items four and five above, purely quantitative work must often be heavily supplemented by qualitative analysis.

(7) Usually the focus is on research and development and/or investment-type decision problems, although operations are sometimes encountered. [1]

The essential feature of cost-utility analysis is to formulate numerical utility values for specific activities and also formulate specific cost factors with those same activities. Thereby one can derive cost-utility ratios and make decisions regarding selection from alternatives based on the relative size of the cost-utility ratios.

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[1] E. A. Fisher, "The Role of Cost and Utility Analysis in Programmed Budgeting," in Programmed Budgeting, pp. 66-67.

Solomon points out the basic problems associated with the use of cost-utility analysis. "A typical decision situation involves three things: (1) an individual faced with the necessity of making a choice, (2) a certain set of alternatives among which the individual must choose, and (3) the system of subjective preferences or values for which the individual ranks the alternatives, choosing that one which stands highest according to his values."[1]

Design

A cost-utility approach involves four distinct steps: (1) careful delineation of the objectives, (2) stipulation of various ways of achieving the objective, (3) a cost-utility analysis of the various alternatives, (4) selection of the most appropriate alternatives based upon systematic analysis. Emphasis throughout is upon the interrelatedness of the many parts and how those parts contribute to the total operating system.

Two phases can be distinguished:

(A) Analyses is made of the programs and activities currently underway in the school system. A coding scheme is derived for the basic elements which become the building blocks for activities and programs.

(B) Determination is made regarding the costs and utilities of the programs and activities by element.

The following diagram is illustrative of the overall design and expected outcomes of the two phases referenced above.

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[1] Herbert Solomon (ed.) Mathematical Thinking in the Measurement of Behavior (Illinois: The Free Press, 1960) p. 158.

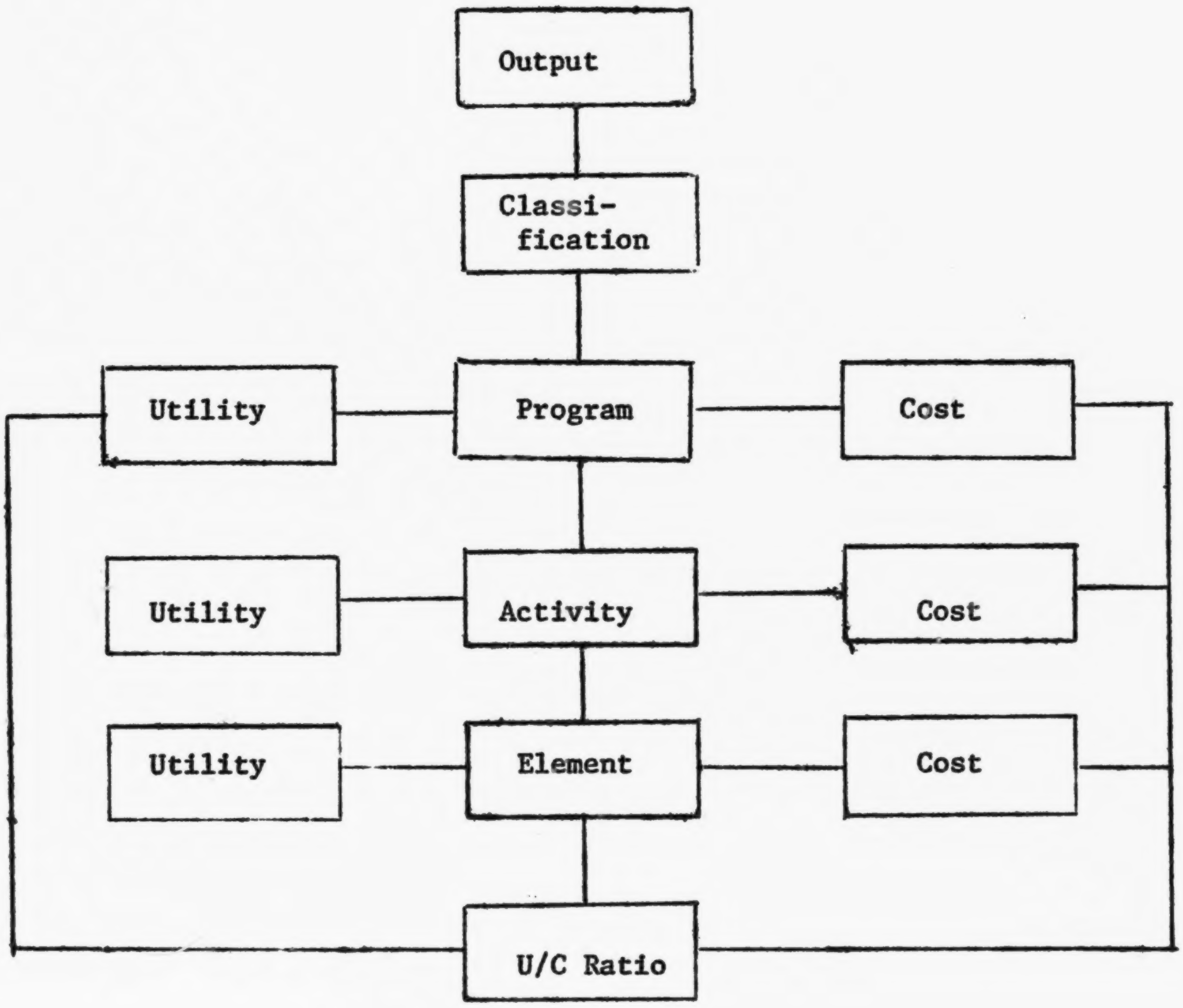
Output
Classi-
fication
Utility
Program
Cost
Utility
Activity
Cost
Utility
Element
Cost
U/C Ratio

Figure 1.--Basic Design

Figure 1 illustrates how cost-utility ratios can be calculated for programs and/or activities. Through these cost-utility ratios relevant information is furnished to the administrator which will assist him in allocating resources.

The computer coding scheme will be in the form of Figure 2 .

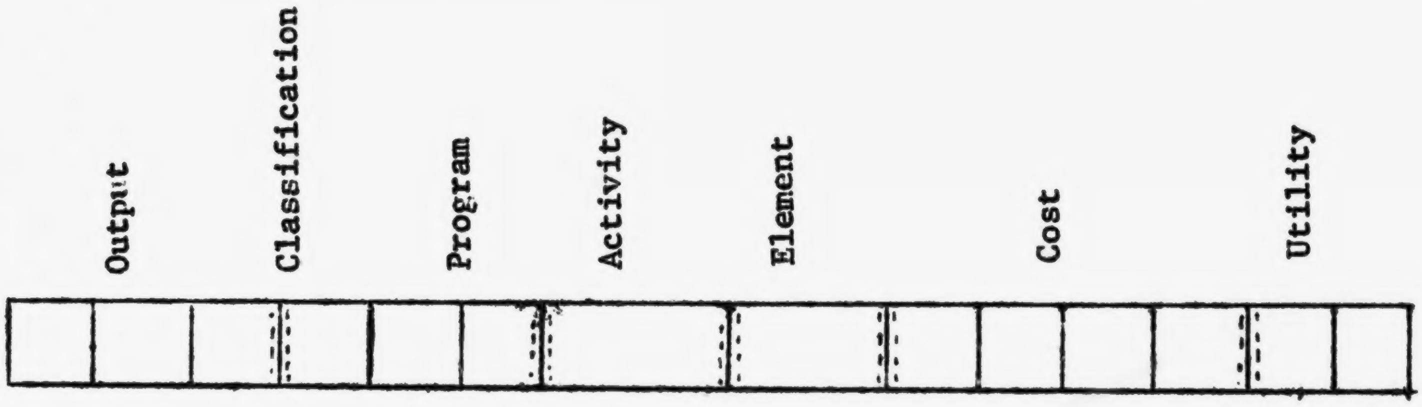

Figure 2.— Coding Scheme

The above coding scheme will furnish a computer record for storage retrieval and comparisons.

Figure 3 illustrates how the various categories might be defined.

Output = Computer programmer

Classification = Instruction

Program = Mathematics

Activity = Algebra

Element = Teacher

Cost = 0.20/hour

Utility = 0.50

Figure 3.—Categories Defined

Reference to Figure 3 suggests that one could use the model to cost out a) a preparation program for a specific job (computer program), b) the total instruction program, c) any program activity, and d) any element of outputs, classifications, programs or activities. The element is defined as the basic unit in the building block system. Since costs and utilities are additive, utility and cost numbers will be ascertained for elements. To determine the utility or cost of "algebra" then, one would merely sum the utilities or costs of all the elements associated with "algebra."

More important than program costs per se the model would permit comparative costs and utilities to be made for different programs or activities. In this fashion more objective decisions could be made regarding the proportionate amount of resources to be allocated among programs.

Activity Analysis

In developing a model of the educational activities, items of information which describe every significant function of the school system must be identified. These items of information consist of broad categories with sets of sub-categories from which specific information is obtained. These broad categories and sub-categories will be identified by a coding system, but also adaptable to all school systems. These items indicate what is being done in the school system.

The broad category of the project is identified as classification. Sub-categories are programs, activities and elements. First a broad classification scheme, consisting of the major functions of the school system, must be determined. Under the program "mathematics," an activity could be geometry. The element, an item which enables the organization to pursue the accomplishment of that activity, must now be determined. In the example used, instruction-mathematics-geometry, the element could be a teacher, text book, teaching machine or other items. After identifying these four levels of categories, a coding system must be determined for the elements and other categories.

The following framework indicates the relationship between each of the categories of the project in the development of the model of the school organization.

DEVELOPMENT PROCEDURE

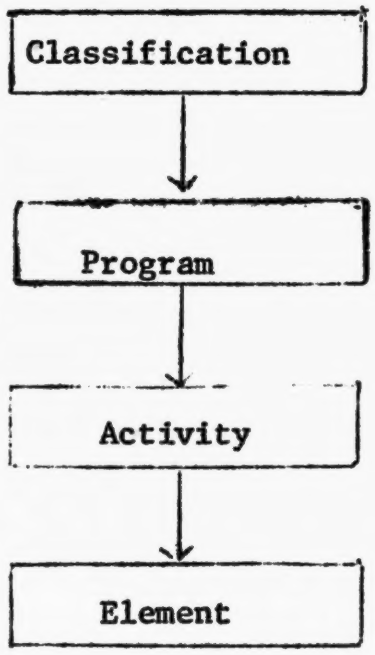

Figure 4.--Development Procedure

The development of the detailed model proceeds from the identification of the macro to the micro categories, classifications to elements. The analysis of the detailed model of the school system, however, proceeds in an inverse order, from the micro to the macro, or from the elements to the classifications.

ANALYSIS PROCEDURE

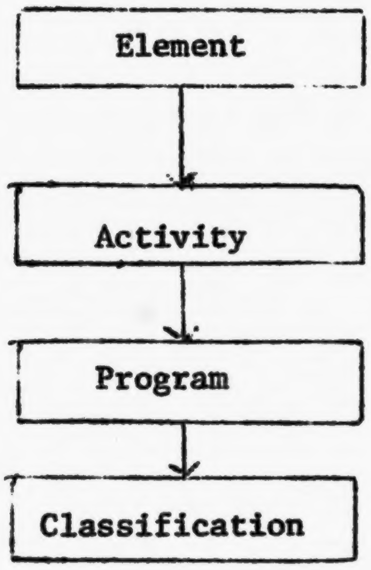

Figure 5.-- Analysis Procedure

They are also additive in this relationship of micro to macro. An activity consists of all the elements attached to it. Combined related activities identify a program. The broadest item of information, a classification, consists of all of the programs related to it. The efficiency of each dimension is therefore determined by the combined cost-utility of each of its sub-dimensions.

Cost-Utility

The end product of the proposed investigation is to develop a cost-utility resource allocation system which will be of assistance to administrators who have responsibility for obtaining and allocating resources for the operation of the local school system. In order to formulate the cost-utility resource allocation system, specific utility numbers must be derived for specific activities and the cost of those activities must be derived. In order to formulate the cost-utility resource allocation system, specific utility numbers must be derived for specific activities and the cost of those activities must be derived. In order to formulate the system, the following steps will be followed.

The information derived from the activity-analysis phase will be utilized in order to assign specific numerical values to utility functions associated with given activities. These utility numbers will be relative numbers scaled from 0.00 to 1.00 and normalized over the entire range of activities. An illustration might help to elucidate the point. (1) Assume five activities a(1); a(2); a(3); a(4); a(5). (2) Arbitrarily assign numbers to each of these five activities, e.g. 100, 50, 30, 20, 10. (3) Compare a(1) >a(2) + a(3) + a(4) + a(5), i.e. 100 >50 + 30 + 20 + 10. (4) Adjust the numerical value assigned to a(1) to make that inequality hold, e.g. 120 >50 + 30 + 20 + 10. (5) Assume that a(2) is greater than the remaining three values associated with the other three activities, e.g. 50 > 30 + 20 + 10. (6) Adjust a(2) to make that inequality hold, e.g. 70 > 30 + 20 + 10. (7) Adjust a(1) since a(2) has been adjusted, e.g. 140 >70 + 30 + 20 + 10. (8) Set a(3) greater than a(4) and a(5), e.g. 30 >20 + 10. (9) Do the necessary adjustments, e.g. 40 >20 + 10. (10) Make the necessary adjustments to the other a(1), e.g. 80 >40 + 20 + 10 and 160 >80 + 40 + 20 + 10. (11) Set a(4) greater than a(5), e.g. 20 >10. The resulting five utility numbers, i.e. 160, 80, 40, 20, 10, which are now associated with the respective five activities represent a quantitative conversion from the qualitative judgements associated with the utilities of the five activities. (12) One final operation needs to be performed. That is, sum the five utility numbers and divide each utility number by that sum, e.g. 160 + 80 + 40 + 20 + 10 = 310; therefore, 160/310 = .516, 80/310 = .258, 40/310 = .129, 20/310 = .064, 10/310 = .032. This will normalize the values of those utility numbers and place them somewhere between 0.00 and 1.00.

This simplified procedure for converting qualitative information into quantitative information denotes a point of departure from which the utility values will eventually be derived. These utility numbers will be building blocks based upon the basic elements associated with each activity. That utilities are additive has been proven in mathematical utility theory. The basic formula is given by $U(A) = U(A_1)p_1 + U(A_2)p_2 + \ldots + U(A_n)p_n$, where $U(A)$ = utility of A, $U(A_1)$ + utility of A_1, and p_1 = probability of A_1. The additive property of utility theory is essential to the formulation of utility numbers which are to be associated with the activities and programs because the utilities are built upon elements. The utility of an activity or program will read as follows: $U(A) = U(E_1)p_1 + U(E_2)p_2 + \ldots + U(E_n)p_n$. The utility numbers will be based on the basic elements and can be utilized in terms of elements, activities, or programs.

Determination of Cost Values

As in the utility numbers, the costing functions will be additive and based upon building blocks derived from the elements of each activity or program. As in the utility numbers assigned, there will, no doubt, be some error involved in the cost numbers derived from these elements. Some arbitrary decision-making must be made regarding the proportionate amount of media equipment, for example, utilized by the math program. However, because of the expected systematic analysis being conducted and because of the detailed activity analysis being conducted simultaneously, it is felt that reasonably accurate cost factors by element can be ascertained. The coding scheme which is to be designed will be associated in a given code according to output, classification, program, element and cost, and utility. In this fashion, various groupings and comparisons can be made according to element, activity or program.

It is assumed that the cost factor, though time consuming and tedious to determine, will be reasonably mechanical insofar as attainment is concerned. The data are hard and countable.

After the utility numbers and cost numbers are derived and assigned according to element, computer programs can be written which will allow quick information retrieval relative to (1) the utility of a program, (2) the cost of a program, and (3) the cost-utility ratios such that different programs or activities can be compared. The coding part of this particular part of the procedure will overlap with that of the activity analysis and the output analysis. When finished, one can get a "read-out" regarding current manpower outputs, required manpower outputs, relative values of different programs, and relative information regarding the expected value or payoff from allocating resources to particular areas of interest.

The final aspect of the cost-utility analysis will be the formulation of a procedure whereby resources can be appropriately allocated to most desirable outputs according to utility. Again, this phase of the project dovetails with the manpower requirement aspect in which the analysis furnishes information regarding the proportionate distribution among major categories of occupations, the school's relative proportion of graduates in those various occupations and, finally, how resources are currently and proportionately allocated across these different output areas. The computer program will include an output that will build frequency distributions of the local and national major occupational categories and also frequency distributions regarding the proportionate amount of resources allocated according to those major occupational categories. The school system officials will be able to monitor constantly their relative allocation of resources. Included with the occupational categories will be categories associated with personal investments for the individual so that the final output will categorize the relative distribution of resources across occupational skills and personal benefits independent of occupational skills. The objective is to design a cost-utility resource allocation system such that the categories can be plugged-in according to the desires of local decision-makers. In this way, the model should be independent of the dichotomized philosophy regarding the objective of education as being (a) to prepare the individual for an occupation, or (b) to prepare the individual for effective living. The assumption of this model will be that they are both important but the relative proportion of resources allocated to each can be decided upon by local authorities so that, however they desire to allocate resources, they will be able to determine how, indeed, resources are allocated.

CHAPTER III

COST-BENEFIT ROLE IN PPBS

As an outgrowth of the Department of Defense's experimental planning techniques designed to improve the effectiveness of governmental programs, the President, in August, 1965, directed most Federal departments and agencies to apply the system of "planning, programming, budgeting" (PPB) to their programs. At this writing, state and local governmental and educational systems are beginning to consider PPB systems of their own design.

A project, financed by the Ford Foundation through a grant to the State-Local Finances Project at George Washington University, calls upon five states, five large cities, and five counties to explore together the problems of coordinating public services and planning programs so that they may achieve public objectives effectively.[1]

There is actually little that is new or novel in the individual concepts of PPBS. The analytical concepts of cost-benefit analysis previously discussed have been known and practiced for many years. The Inter-Agency Committee on Water Resources, for example, was a pioneer in this area with the May, 1950, publication of its report of "Proposed Practices for Economic Analysis of River Basin Projects." What is new is the combination of a number of concepts into a single package and the systematic application of that package to total system planning.

The term "program," as used in this study, refers to an integrated activity or set of activities, including the combination of personnel, equipment, facilities, finances, etc., which, together, constitute an identifiable means to some objective of the system.

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[1] U.S., Congress, Senate, Committee on Government Operations, Subcommittee on Intergovernmental Relations, Criteria for Evaluation in Planning State and Local Programs: A Study, 90th Congress.,1st Sess., 1967, p. iv.

The term "program budgeting" is not equivalent, in this context, to PPBS. Program accounting and program budgeting are basic conceptual elements of a PPBS but are limited to accounting and budgeting systems emphasizing categorization schemes by programs. The primary distinctive characteristics of PPBS as defined by Hatry and Cotton are:

1. It focuses on identifying the fundamental objectives of the government system and then relating all activities, regardless of organizational placement, to these.

2. Future year implications are explicitly considered.

3. All pertinent costs are considered--including capital costs as well as non-capital costs, and associated support costs (such as employee benefits, associated vehicle and building maintenance costs) as well as direct costs.

4. Systematic analysis of alternatives is undertaken. This characteristic is the crux of PPBS. It involves: (a) identification of the governmental [educational] objectives; (b) explicit, systematic, identification of alternative ways of carrying out the objectives; (c) estimation of the total cost implications of each alternative; (d) estimation of the expected results of each alternative; and (e) presentation of resulting major cost and benefit tradeoffs among the alternatives along with the identification of major assumptions and uncertainties.[1]

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[1] H. P. Hatry and J. F. Cotton, Program Planning for State, County, City (Washington, D.C.: State-Local Finances Project of the George Washington University, 1967), p. 15.

Dr. Selma Mushkin, Director of the State-Local Finances Project, outlines the following system requirements in the preparation for implementing a PPBS:

1. Clarifying and specifying the ultimate goals or objectives of each activity for which a government budgets money.

2. Gathering like activities into comprehensive categories or programs designed to achieve the specified objectives.

3. Examining as a continuous process how well each activity or program has done--its effectiveness.

4. Analyzing proposed improvements or new program proposals to see how effective they may be in achieving program goals.

5. Projecting the entire costs of each proposal not only for the first year but for several subsequent years.

6. Formulating a plan, based in part on the analysis of proposed cost and effectiveness, that leads to implementation through the budget.[1]

Figure 6 represents the flow of information in a PPB system.[2] Three main products of this system include: (1) the budget; (2) the multi-year (usually five years) plan; and (3) program analyses. Program cost estimates are essential to each of these three PPB system elements. It is important to note that there are major differences in the precision required for each of these PPB products:

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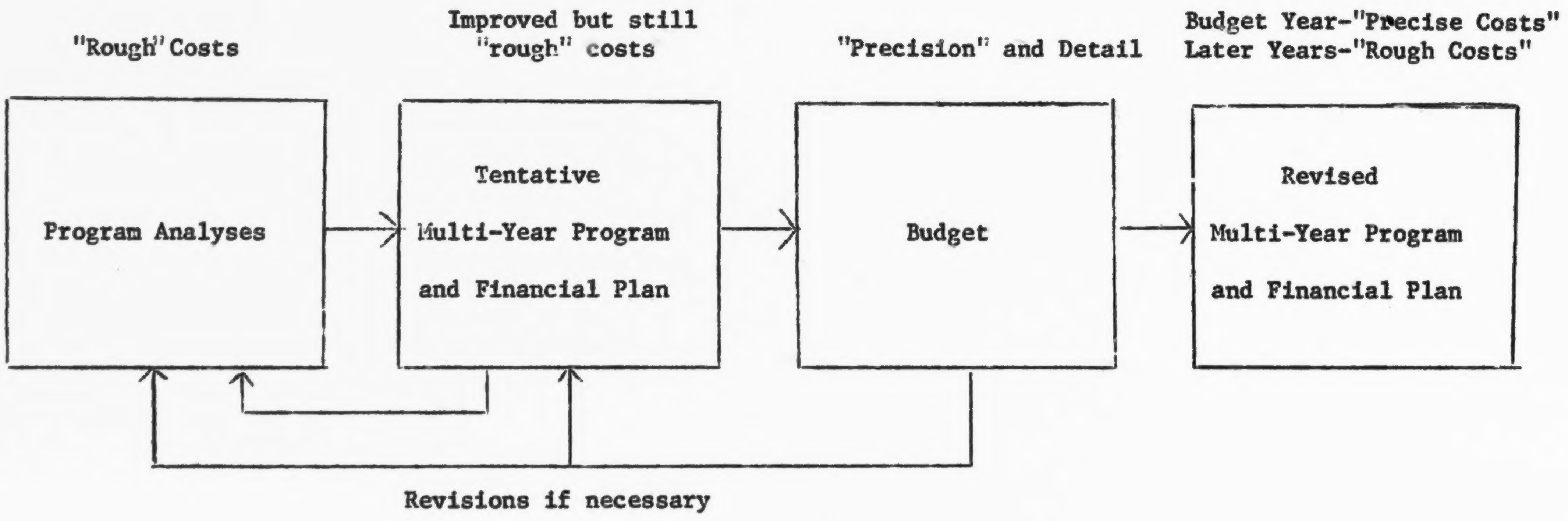
[1] George Washington University State-Local Finances Project, Planning, Programming, Budgeting for City, State, County Objectives, PPB Notes 1-8 (1967), p. 1.

[2] Ibid., Note 6, p. 2.

Figure 6.--PPB System Cost Requirements


"Rough" Costs
Improved but still "rough" costs
"Precision" and Detail
Budget Year-"Precise Costs"
Later Years-"Rough Costs"
Program Analyses
Tentative Multi-Year Program and Financial Plan
Budget
Revised Multi-Year Program and Financial Plan
Revisions if necessary

> 1. The Budget:
>
>   (a) Cost estimates are required for only a single future year (or two years if the budget covers a biennial period).
>
>   (b) The cost estimates need to be as precise as possible.
>
>   (c) The budget, and, therefore, the categories in which costs are presented, should reflect the needs of the management control process. Neither the multi-year financial plan nor individual program analyses are intended for management control purposes as is the budget. . . . While program budgeting is helpful in evaluation of the budget, it is not essential to a PPB system as long as there is a cross-walk to assure compatibility between the categories used for planning programs and the budget categories.
>
> 2. The Multi-Year Financial Plan:
>
>   The purpose of the multi-year financial plan is to provide improved perspective as to the dollar implications of the approved programs. . . . Cost estimates for this plan, particularly for the years beyond the coming budget year, do not have to be, and, in fact, cannot be, considered very precise. . . .
>
> 3. Program Analyses:
>
>   The emphasis is on the ability to estimate the complete cost implications of each of the wide variety of program alternatives which might be proposed. All relevent costs both immediate and future need to be considered... for PPB analyses, total program cost estimates within plus or minus ten per cent would usually be considered quite accurate. . . .[1]

Hatry and Cotton recognized PPBS as a useful planning tool to be used along with other yardsticks in public decision making. They point out that "technical answers to questions cannot reflect the full gamut of political and strategic considerations that guide policy decisions."[1] A consistent feature in the literature describing the potential of PPBS is that it can help state and local public education administrators deal with problems ahead of time instead of as day-by-day crises arise and can place in much improved perspective the principal issues on scarce resource allocation. Educational administrators utilizing PPBS concepts will find themselves less in the position of "budget cutters" and more in the active role of considering important program options in terms of real educational needs.

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[1] *Ibid.*, pp. 2-3.

In a study submitted to the U. S. Senate, Committee on Government Operations, by the Subcommittee on Intergovernmental Relations, Subcommittee Chairman Edmund S. Muskie commented: "As a tool for improving the efficiency and effectiveness of state and local governments, planning, programming, budgeting systems seem to hold a promise well worth pursuing."[2]

Cost Benefit: A Case Study

Cost-Benefit analysis is an important part of the analytical process of PPBS. It is a management tool that attempts to quantify and measure the costs and benefits of various alternatives proposed to reach pre-established objectives. In this particular case study, our alternatives are the existing traditional program for teaching mathematics in grades 7-12 at The University School, Florida State University, vs. implementing the use of CAI (Computer Assisted Instruction). The definition, objectives, and criteria are spelled out in operational terms in the program memorandum.[3] While we have only two alternatives, there could

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[1] Hatry and Cotton, op. cit., p. 36.

[2] U.S., Congress, Senate, op. cit., p. iv.

[3] See Page 41 for a sample copy of the Program Memorandum.

PROGRAM MEMORANDUM	**REPORTING ORGANIZATION**	**CODE**

PROGRAM CAT. CODE	PRO. SUBCAT. CODE	PRO. ELEMENT CODE	PRO. SUB-ELE. CODE	PRO. COMPONENT CODE

DEFINITION

MATH PROGRAM
FOR 1969-70 COHORT
TRADITIONAL PROGRAM

ACCOUNT NUMBERS:

OBJECTIVES

ALTERNATIVE # 1

GRADE / YEAR	INPUTS TEACHER COSTS	PARA-PRO. COST	CONSUM. MATERIALS	NON-CON. MATERIALS	TEXTS	SUPPORT SERVICES	ADMINISTRATION *	OVERHEAD	INITIAL INVESTMENT	TOTAL DIST. INVESTMENT	IMPUTED COST	TOTA
7th / 1st												
8th / 2nd											STUDENT & TEACHER TIME ETC.	
9th / 3rd												
10th / 4th												
11th / 5th												
12th / 6th												
TOTAL												

CRITERIA	**EVALUATION**
	For details see ———

COSTS					RECURRING					6 YEAR TOTALS
-2	Last Yr.	Present Year			1	2	3	4	5	
		BUD	ACT	VAR						
		Cost	Per	Pupil						
			Time							
		COST OF IMPLEMENTATION		Fixed Cost						
				Vari. Cost						

	SOURCES OF REVENUE
1st yr.	
2nd yr.	
3rd yr.	
4th yr.	
5th yr.	
6th yr.	
TOTAL	

VS.

VS.

PROGRAM MEMORANDUM	**REPORTING ORGANIZATION**	**CODE**

PROGRAM CAT. CODE	PRO. SUBCAT. CODE	PRO. ELEMENT CODE	PRO. SUB-ELE. CODE	PRO. COMPONENT CODE

DEFINITION

MATH PROGRAM
FOR 1969-70 COHORT
CAI PROGRAM

ACCOUNT NUMBERS:

OBJECTIVES

ALTERNATIVE # 2

ALL INFORMATION ABOVE
MUST BE CONSIDERED
FOR THIS ALTERNATIVE

CRITERIA	**EVALUATION**
	For details see ———

COSTS										6 YEAR TOTALS
-2	Last Yr.	Present Year			1	2	3	4	5	
		BUD	ACT	VAR						
		Cost	Per	Pupil						
			Time							
		COST OF IMPLEMENTATION		Fixed Cost						
				Vari. Cost						

							PURE ACADEMIC OUTPUT				SELF-CONCEPT VALUE ADDED	FOLLOW UP INFORMATION	COST-EFFECTIVENESS ANALYSIS	COST-BENEFIT ANALYSIS	COST-UTILITY ANALYSIS	SUMMARY & RECOMMENDATIONS
ISTRATION	OVERHEAD	INITIAL INVESTMENT	TOTAL DIST. INVESTMENT	IMPUTED COST	TOTAL COST	→ OUTPUT	BEHAV. OBJ. TEST SCORES	STATE & NATL. TESTS	% PROMOTED	DROPOUTS						
			STUDENT & TEACHER TIME ETC.					SEE SUPPORT DOCUMENT FOR ITEM ANALYSIS				JR. COLLEGE ATTENDANCE A A DEGREE YEARS ATTENDANCE COLLEGE AVG. YRS. COLLEGE ATTENDANCE JOB STATISTICS LEISURE TIME RATIO	PROGRAM EFFICIENCY: $\frac{\text{STANDARD COST/UNIT OF OUTPUT}}{\text{ACTUAL COST/UNIT OF OUTPUT}}$ PROGRAM EFFECTIVENESS: $\frac{\text{ACTUAL OUTPUT/TIME PERIOD}}{\text{PLANNED OUTPUT/TIME PERIOD}}$	COST-BENEFIT ANALYSIS RATIO $\frac{C}{B} < 1$		
									# OF GRADUATES				ADVANCED PLACEMENT EDUCATIONAL PRODUCTIVITY $= \frac{OE_D}{IE_D}$			
EVENUE																

VS.

								OE_D = OUTPUT RATIO OF SEMESTER HOURS OF COLLEGE CREDIT EARNED BY ADVANCED PLACEMENT IN MATH BY DISTRICT SCHOOL EXPRESSED IN PER CENT OF TOTAL SEMESTER HOURS EARNED. IE_D = INPUT RATIO OF AVERAGE TEACHING COST IN MATH BY DISTRICT EXPRESSED IN PER CENT OF TOTAL AMOUNT EXPENDED BY ALL SCHOOLS.		SUMMARY & RECOMMENDATIONS

just as easily be more. However, only relevant and feasible alternatives should be considered. These are referred to as the feasible set.

The first part of our memorandum identifies the alternative under consideration. This alternative is carefully defined. The objectives and criteria for evaluation should be the same for all alternatives considered. The space for evaluation is to be filled by the administrator at the end of the program. Such feedback consideration is essential for future planning. If the evaluation points to less than anticipated benefits or more than anticipated costs new alternatives should be considered.

Consideration of Costs

We attempt to compute anticipated costs over a longer time horizon than is normally done in education. Educators must begin to consider the long-range implications of their present decisions. For comparison purposes we have a place to list the cost of any on-going program for past years. Next, to permit uniform analysis and comparison, we use a common time span for all alternatives under consideration. In this case our time span is six years. To get a picture of true total costs we must consider the costs, if any, of implementation--the short term costs, and the long term costs. Only when data is available on the alternatives can costs comparisons be made in light of the predicted benefits. To help the administrator in making operational decisions we have also divided recurring costs into fixed and variable costs. Only the variable costs can be adjusted once a particular program is selected from among the alternatives. Such information is an indication to the administrator of how much flexibility he will have, once committed to a particular alternative. After implementation the variable costs are by far the most relevant for short-run decision making.

Inputs

The cost matrix relates inputs with outputs. The inputs are divided into fixed and variable costs as well as imputed costs. Such a matrix should satisfy the demands of Burkhead.

In cost-benefit analysis every effort is made to measure comprehensively all costs, monetary and imputed, that are required for a particular educational program. The ideal of computing total costs and benefits is a long way off, but the closer we come to this ideal the more rational will be our decisions.

On our cost matrix we see the cost of all identifiable variables. In accordance with the suggestion of Benson, the imputed costs are estimated costs for teacher and student time. Imputed costs are, at the moment, nothing but educated hunches.[1]

Multi-year Financial Plan

Below the cost figures is a table showing anticipated revenues for the time period under consideration. While this is not directly part of cost benefit it is very useful to the administrator. Long-range planning should consider potential income as well as potential expenditures. Furthermore, some alternatives may bring with them extra funds. For example, our alternative for CAI may very well promise, as a concomitant, extra funds from grants. Naturally, such information is relevant to the decision maker.

Output

This is an area seldom considered by educators. The problem of measurement of educational outcome remains a major obstacle for even those educators and scholars from other fields who are committed to this economic criterion. Here we are suggesting some outputs that, with further investigation, might possibly lead to accurate measurement.

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[1] Jesse Burkhead, Input and Output in Large-City High Schools (Syracuse, New York: Syracuse University Press, 1967), p. 9.

Academic Fulfillment of Behavioral Objectives

Each of the grades is divided into components which are the instructional objectives. These are made very explicit in that they have all been turned into behavioral objectives. The criteria for satisfaction of this objective is the fulfillment of this body of knowledge in behavioral terms. Each target group, slow learner, college capable, etc., has its own behavioral objectives. A very significant part of our output in teaching the academic skill of mathematics will be the success of teaching these behavioral objectives. This assumes that our behavioral objectives are properly drawn up. Here we will consider the number promoted and the number of dropouts. Fulfillment of these objectives is measured by teacher tests and state and nationally normed tests.

Psychological Measurements

For this type of output we will attempt to measure growth in self-concept. Of course, this must be in terms of value added and, therefore, calls for a pre- and post-test for each of the six years. A student opinion poll has been suggested, but we have not included this as part of our model.

Cost-Effectiveness Analysis

Here three formulas have been suggested. Unfortunately, all are for ex-post evaluation. However, some might be adjusted for ex-ante evaluation.

$$\text{Efficiency Ratio} = \frac{\text{Standard Cost/Unit of Output}}{\text{Actual Cost/Unit of Output}}$$

$$\text{Time Effectiveness Ratio} = \frac{\text{Actual Output/Time Period}}{\text{Planned Output/Time Period}}$$

$$\text{Educational Productivity:} \quad \frac{\text{Output}}{\text{Input}} = \frac{\text{OEd}}{\text{IEd}}$$

OEd: a ratio of semester hours of college credit earned by advanced placement in mathematics, expressed in per cent of total semester hours earned.

IEd: a ratio of average teaching costs in mathematics, expressed in per cent of total amount expended.

As the purpose of cost-effectiveness analysis is to aid the decision maker in choosing from among feasible alternatives on a basis of least cost and greatest effectiveness, the three ratios we suggest should aid the decision maker if he is judicious in their use. Cost-effectiveness, thus, should be considered a tool for micro-analysis. It appears that the information generated by this analysis will be of the most value to the educational administrator.

Cost-Benefit Analysis

This is a more "advanced" form of analysis. This intermediate analysis evaluates programs in terms of their objectives. Benefits unrelated to objectives are not considered benefits; these by-products are referred to as spill-overs. This type of analysis would seem supplementary to cost-effectiveness. However, a program may be quite effective yet not meet the necessary requirements of its objectives; thus, cost-benefit analysis is quite essential.

The goal is to choose the program that allows the maximum benefits for the least cost or similar cost. At all times, benefits should exceed costs:

$$\frac{C}{B} < 1$$

Measurement criteria for the benefits must be specified in advance and in terms of program objectives. Cost-benefit analysis will probably be of the most use to the educational planner and the economist.

Cost-Utility Analysis

This is a macro-level analysis. It is most difficult to measure, and is also very expensive because it calls for sophisticated measurement and longitudinal studies.

Summary, Conclusions, and Recommendations

A summary of each alternative is called for at this point. This is also the place to consider spill-overs to society, to the individual, and to the educational institution. Finally, this is the place where the research team makes its recommendations to the decision maker. Then it is up to him to make the decision. Remember: This methodology does not make decisions, but, if used judiciously, it will aid those making recommendations to the decision making body.

Post Evaluation

Cost-benefit is a pre-programming process. A great deal of uncertainty exists for educational decision makers. Furthermore, in the best of worlds things do not work out as planned. Ex-post evaluation is, therefore, essential. Educators, like everyone else, must look at their mistakes. How effective has our program been? How could it be better? What were our failures? Ratios are a convenient method used by the business world to evaluate corporation. We suggest the following ratio for educational programs:

$$\text{Effectiveness Ratio} = \frac{\text{Actual Output/Time Period}}{\text{Planned Output/Time Period}}$$

This formula will show clearly whether or not targets were reached. It is commonly agreed that program effectiveness should be determined by analysis of outputs achieved compared to planned outputs.

$$\text{Efficiency Ratio} = \frac{\text{Standard Cost/Unit of Output}}{\text{Actual Cost/Unit of Output}}$$

If we are to engage in reasonably intelligent planning we must consider variances. This ratio is an expression of the overall variance.

Summary

There are tremendous problems in computing costs and benefits in situations such as the one discussed. Recently several similar studies have attempted to compute benefits and costs. "Project Talent" is one such study that is primarily concerned with examining the feasibility of actually computing relative costs and benefits of changes in school inputs. In this case the effect of a change of pupil-teacher ratio, a higher teacher's salary scale, an educational television set-up, and other alternatives are introduced to determine how much student achievement is enhanced by each factor. The investigators of this project conclude that although there are numerous and gigantic problems involved in such quantitative estimates of costs and benefits, it is definitely feasible to make these cost-benefit comparisons and, at the same time, make them sufficiently accurate to improve educational outcomes.[1]

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[1] James R. Rinehart and James F. Cummings, "Spending for Education--How Critical Have We Been?" Educational Forum (May, 1965), 461-466.

CHAPTER IV

COST-UTILITY SYSTEMS IN SCHOOL ADMINISTRATION

The concept of cost-utility assumes that for any particular program or activity the cost can be assigned a number and the utility (or benefit) of the program can be assigned a number. The ratio of the two numbers, the cost-utility ratio, can be compared with the ratio for any other project. Generally, the project with the lesser ratio would be assigned a higher priority than the other. If only one of the two projects could be included in the budget, the project with the lesser ratio would be that one. The value from each unit of cost would therefore be maximized.

This chapter deals, first, with the cost part of the ratio, and then, with the benefits (or utility) aspects. Only a few notes and some comments on previous discussions and studies on costs are included; the greater part of the chapter is a discussion of utility.

Costs

"Costs" include all the expenses of a program or activity. These would include financial expenses: costs of physical facilities (buildings, grounds, and equipment), personnel, expendables (electricity, water, paper supplies, etc.), and distributed costs such as those of general administration.[1]

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[1] Expenses can also include costs in values. For example, when land is acquired for a city school site, people must be moved from their homes. If a family has lived in a house for fifty years and had intended to live there for another fifty or more, the relocation will not be just financially expensive, it will also be emotionally disturbing. That disturbance is a "cost" that should be considered and included in the cost-benefit ratio.

Several points can be made on the simpler topic of financial expenses, however. First, the cost of a project should include the cost of buildings, grounds and equipment. In particular, the costs should reflect the depreciated value of these items. Conventional budgeting does not make clear the fact that a student in a new school is receiving perhaps fifty dollars a year more for his education than a student in a school that has depreciated to near zero value. Second, the future cost of a program should be considered as well as first year cost. Department of Defense officials frequently pointed out the importance of long-term planning and costing in the Department's decision making process. Frequently the first year cost represents only the "camel's nose under the tent." Administrators sometimes find themselves committed to programs of constantly increasing cost for which they were not prepared, with the only alternative being to scrap the program and accept a virtually complete loss of the first year expenditures. Programs should be costed on a long-term basis, for example, on the cost for five years, for ten years, and for twenty years. Third, the cost of the project should not include expenses imposed upon it by other elements of the system, but the cost should include a fraction of the general administrative and organizational costs. For example, a new class in electronics may have to use a ten thousand dollar a year teacher rather than a six thousand dollar a year equivalent simply because the more expensive teacher is already in the system and has to be given a job. The four thousand dollar difference should not be ascribed to the electronics program but rather to the general organization. The electronics program would have to share in the general administrative and organizational costs, however, for some of the administrator's time is spent on electronics program matters and some of the expense of seniority pay raises and other morale boosting practices goes to improve the electronics program environment. Generally, the allocation of costs will leave the program cost just about where they started, with the exception that personnel expenses would be based upon average salaries rather than upon the exceptionally high or low salaries that might apply at the beginning of a program.

Two costs that are not specifically financial (though they might be convertible into dollar costs) are organizational morale and public relations, when these are adversely affected by a program. The literature of management is full of examples that could be used to illustrate the point, and practical decision makers are keenly aware of professional and public opinion. However, no school district lists either organizational morale or public relations on its balance sheet. Yet these costs could well be estimated in dollars and included in the cost part of the cost-benefit ratio.

The "costs" of vocational-technical education used in this report are classed as direct and indirect, and from two sectors, private and public. The direct costs are those most easily identified and data collected. The indirect costs of the private sector are, primarily, the foregone earnings, frequently referred to as "invisible" opportunity costs.[1]

Naturally, both the direct and indirect costs will vary according to the type of vocational-technical schooling or training being pursued, the time the schooling or training is being pursued, as well as the geographic differences.

The time element is a very important factor from the standpoint of the individual. This factor takes on an even greater magnitude when one considers the material used by Mincer:

> . . . foregone earnings constitute over half of the total costs of schooling and about 75 per cent of the costs borne by students. Foregone earnings bulk even more if the costs are borne by trainees on the job.[2]

The implications here are significant to the decision makers in planning educational curricula and facilities. If, in fact, the vocational-technical education or training becomes a part of high school education, certain questions might be asked.

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[1] Jacob Mincer, "On-the-job Training: Costs, Returns, and Some Implications," Journal of Political Economy, Supplement, LXX (October, 1962), p. 51.

[2] *Ibid.*, p. 52.

1. Does the high school plan involve more or less public costs than does a post high school plan?

2. Does the high school plan involve more or less private cost than does a post high school plan?

3. Regardless of the costs, what might be the employment advantages or disadvantages of the high school plan or post high school plan?

Corazzini, in his study of the data from the Worcester, Massachusetts, school system, arrived at some very interesting cost figures involving public high schools, vocational high schools, and post high school vocational-technical programs.[1] The public cost of vocational-technical education is always assumed to be higher than general education.[2] The private costs of general education and vocational high school education are equal for students, while the private costs of post high school vocational education are more than twice as high as the other two compared in the Corazzini study.[3] (See Table 1.)

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[1] Corazzini, op. cit., p. 47.

[2] Burkhead writes in this connection: ". . . the inclusion of foregone earnings in educational costs is quite appropriate for an individual who wishes to calculate his own net return from an investment in education but it is much more questionable in application to estimates of the full cost to society of investment in education for a nation. It is possible to imagine that several thousands of students now in college could find alternative employment, although job opportunities have recently been limited for this age group. But it is difficult to imagine that several million high school and college students could find employment without a reordering of the work force, and indeed of the whole economy, to lower skill levels. Marginal comparison and opportunity cost concepts have no meaning applied to greatly different kinds of economic organizations." p. 5.

[3] Corazzini, op. cit. p. 47.

TABLE 1

TOTAL RESOURCE COSTS, WORCESTER PUBLIC HIGH SCHOOL
WORCESTER BOYS' VOCATIONAL SCHOOL
WORCESTER 13th AND 14th GRADE VOCATIONAL-TECHNICAL
SCHOOL, 1963-64[a]

	$ per Pupil		
	Public high schools	Vocational high schools	Post-high school vocational-technical
Total Public Costs	532	1,210	1,230
1. Current cost	452	964	984
2. Implicit rent	59	165	165
3. Property tax loss	21	81	81
Total Private Costs	1,176	1,176	2,544
1. School-related costs	56	56	121
2. Foregone earnings	1,120	1,120	2,423
Total Resource Costs	1,708	2,386	3,774

[a] Ibid.

Utility

Utility is difficult to work with. Though economists talk about it often enough, they do not provide much help in specifying utility numbers. Nor are educational administrators in much of a position to use the limited help the economists can give. For the administrator the question quite frequently is: To use or not to use cost-effectiveness or cost-utility analysis. A superintendent, forced to make a decision, might use either approach. (1) He might decide not to use cost-benefit except for problems that are specifically financial; or (2) he can use the cost-benefit concept in a few other situations besides those that are financial.

Even Robert McNamara and Charles Hitch have not completely applied cost-benefit analysis everywhere. Hitch says:

> Program budgeting and systems analysis, while mutually reinforcing in a PPBS system, are distinct in the sense that either can be used without the other. In Defense, the program budget (or Five Year Program) is co-extensive with the department, while systems, or cost-effectiveness analysis has been applied successfully only to certain problems of choice in some parts of the Department. Contrarywise, some highly useful cost-effectiveness studies were completed at RAND and elsewhere before the elements of program budgeting were conceived, let alone adopted.[1]

Further:

> No program structure in itself provides a key to optimal trade-offs among objects of expenditure. This is the role of cost-benefit systems analysis--in which, I confess, we have so far made little headway at the University of California.[2]

In cases where the superintendent uses the cost-benefit (utility) concept in situations basically non-financial, he can apply it to "degenerate" ratios, those in which both numerators or denominators are equal. Hitch says it this way:

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[1] Charles J. Hitch, "The Systems Approach to Decision-Making in the Department of Defense and the University of California," Operational Research Quarterly, XIX (April, 1968), 37.

[2] Ibid., p. 43.

> Economic analysis is concerned with the allocation of resources. Its basic tenet is to maximize the value of the resources used. In business this reduces itself to maximizing profits, because both income and outgo are measured in dollars. In Defense, and, generally, in the public sector, we lack a common valuation for objectives and resources. Therefore, we have to use one of two weaker maxims: maximize objectives for given resources, or minimize resources for given objectives.[1]

The first maxim is used by the superintendent in setting up the entire budget, for today funds commonly are appropriated on the basis of the significance of the problem, not on the basis of the utility of the solution, so that the total amount of the budget is determined by the community with little or no reference to specific allocations of specific expected utility. With the total budget amount as a given, the superintendent's job is to maximize the objectives. The first maxim is also used to evaluate new programs. In addition economists use three criteria in welfare economics. The first is "The Pareto criterion.--Any change which harms no one and which makes some people better off (in their own estimation) must be considered to be an improvement."[2] A large percentage, perhaps most, of the superintendent's decisions are made by this criterion. The second is "The Kaldor criterion.--A change is an improvement if those who gain evaluate their gains at a higher figure than the value which the losers set upon their losses."[3] This, too, is much used by superintendents. The third criterion is "The

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[1] Charles J. Hitch, "Program Budgeting," Datamation, XIII, No. 9 (September, 1967), 40.

[2] William J. Baumol, Economic Theory and Operations Analysis. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1961), p. 267.

[3] Ibid., pp. 268-269.

Bergson criterion.--The only way out of the problem is the formulation of a set of explicit value judgments which enable the analyst to evaluate the situation. These judgments as to what constitutes justice and virtue in distribution may be those of the economist himself or those set up . . . by some other unspecified person or group. In effect, this amounts to the construction of an indifference map ranking different combinations of the utility which may accrue to the various members of society. . . . Such an indifference map is called the social welfare function, and it does permit the analyst to judge definitively whether or not a proposed policy change is an improvement."[1]

Superintendents seem to combine the predetermined budget with the Pareto criterion and with the first maxim (maximize objectives for given resources). It works in the following way. The budget is given as the preceding year's budget plus a little more. The Pareto criterion allows the superintendent to use the additional funds, after allowance for the demands of inflation, for new programs. So the resources to be provided are given, and the first maxim is used to determine their use.

Sometimes the first maxim is used with the Kaldor criterion, but use of the Kaldor criterion requires a brave superintendent. Administrators commonly avoid use of the Kaldor criterion and substitute the Pareto criterion instead by keeping discretionary funds firmly in their pockets, arbitrarily giving it out as a form of personal patronage. By never putting money to the same use for two years in a row, or using it in any observable pattern, they prevent any group from claiming it by precedent, thereby keeping the option of using the Pareto rather than the Kaldor criterion.

The second maxim (minimize resources for given objectives) is quite a powerful maxim. If there is a less expensive way to get the job done, use it. Note that the objective is not restricted to the use of any particular method or materials. E. S. Quade comments that:

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[1] Ibid., pp. 210-211.

> They [the alternatives] need not be obvious substitutes for one another or perform the same specific functions. Thus, to protect civilians against air attack, shelters, 'shooting' defenses, counterforce attack, and retaliatory striking power are all alternatives.[1]

With respect to educational objectives, students might learn to read by working in a reading laboratory with tachistoscopes, etc., or by being put into an auto shop alone with their cars and the repair manual.

A brief digression on objectives may be acceptable here. It is commonplace to state that objectives must be expressed in terms that teachers and parents can understand; the behaviorists have stressed that point sufficiently. It is not so common to observe that objectives should contradict each other as little as possible. Most people would recognize an incompatability between the objectives of "developing the habit of critical thinking" and "responding immediately and whole-heartedly to all teacher commands." Less apparent may be such conflicts as that implicit in "study Euclidean geometry to develop the habit of divergent thinking."

The total objectives of a program may be defined as the total effects of the program. Unintentional effects of a program, such as loss of teacher or student morale, increase of bureaucratic red tape, and improvement of student reading skills, must be included in either the objectives of a program or in its costs. In either case they may prevent the problem from being considered under maxims one and two.

Besides the procedures described above three more specific procedures are possible for the superintendent. First, he may avoid direct cost-benefit analysis by establishing a measure of effectiveness (such as test scores) for each possible type of objective and combining the measures with appropriate weightings into an index. (The specifications for the index would also have to include lower limits for each of the measures.) Any one activity might affect several measures. The superintendent's task would then be to maximize the index within the constraints of specified least measurement values and total available resources. The index is a form of social welfare function. It is nothing more than a mathematical expression of the superintendent's values (or opinions or prejudices, depending upon your point of view). This index procedure is appealing. If it can be developed it reduces the whole problem down to working with just one number. As it stands it has a major drawback, however. A statement by E. S. Quade on a similar topic suggests the difficulty; and his view will be useful later. He states:

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[1] E. S. Quade, "Cost-Effectiveness: An Introduction and Overview," Transportation Journal, V, No. 4 (Summer, 1966), 7.

> Having formulated and researched the problem--that is, clarified the issues, limited the extent of the inquiry, searched out the necessary data and relationships, and identified the various elements--the process of analysis may be outlined as follows. The consequences of choosing an alternative (which may have to be discovered or invented as part of the analysis) are obtained by means of the models. These consequences tell us how effective each particular alternative is in the attainment of the objectives (which requires that we have a measure of effectiveness for each objective) and what the costs are. The criterion can then be used to arrange the alternatives in order of preference.
>
> Unfortunately, things are seldom so tidy: alternatives are not adequate to attain the objectives; the measures of effectiveness do not really measure the extent to which the objectives are attained; the predictions from the model are full of uncertainties; and other criteria which look almost as attractive as the one chosen may lead to a different order of preference. When this happens, we must begin again. The key to successful analysis is iteration--a continuous cycle of formulating the problem, selecting the objectives, designing better alternatives, collecting data, building new models, weighing cost against performance, questioning assumptions and data, reexamining the objectives, opening new alternatives, and so on, until satisfaction is obtained or time or money forces a cut-off.[1]

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[1] *Ibid.*, p. 8.

The decision-making process has to involve the iterative process, and the index is so neat that it tends to discourage any such reexamination. The problem lies in the difficulty of specifying objectives. First efforts at the specification of objectives necessarily involve implicit cost estimates and evaluations. For example, the objective that "every student is to read at or above his grade level as determined by national test X" implies the statement of acceptable cost: "No cost is too high." The superintendent may mean exactly that, but it is unlikely. We would have to refine his objective in the light of information on the likely costs of reading skill improvements. Development of an index for the entire system would be based on rough estimates of costs of the programs involved. The index should be revised as the estimates are made more precise, but the form of the index discourages revision.

A second possible procedure can be a little more accurate than the index because it uses the concept of marginal utility. The procedure assumes that the established body of the system is designed and operating satisfactorily. The purpose of the procedure is, therefore, to maximize the utility of funds at the margin of the budget, that is, the funds that represent an increase in the budget or that were not permanently assigned to any operating division. The procedure also assumes that the indifference curves of any two objectives will be approximately hyperbolic in shape but that in the region of interest in applying marginal utility they will be approximately straight lines of equal slope. Linear trade-offs of the type $y=kx$ can then be determined for each pair of objectives and checked for consistency. The trade-offs can then be combined to establish all utilities in terms of one objective. For example, given that A, B, and C are measures of objectives such as (A) average reading level, (B) average arithmetic grade level, and (C) average physical skills grade level. Assume that it can be determined that $A = 1.5B$, $B = 2C$, so that $A = 3C$. Then the utility of any program can be expressed in terms of C. If program X yields $0.5A + 1.2B + 0.1C$ for M dollars, then its utility is $0.5\,(3C) + 1.2(2C) + 0.1C$ or $4.0C$. The cost is M, so the cost-benefit ratio is $M/4C$, where the numerator is in dollars and the denominator is in physical skills grade level units, both of which will be common to all other cost-benefit ratios developed in the same system.

It must be noted that the trade-off equations are not fixed. They represent straight line segments of a curve. As the margin of the budget changes because allocation decisions are made, the equations must be determined over again. This is the iterative process described earlier in the statement by Quade. Also, the procedure does not indicate how the equations are determined, only that the superintendent must compare objectives (not programs) two at a time.

A third possible procedure can produce similar results. The procedure begins on the margin of the budget by assuming that most of the budget (perhaps seventy per cent) has been predetermined. All programs that can be purchased by the expenditure of some small fraction of the budget (say one-half of one per cent) are listed. A matrix is established with all the programs listed on the top and on the side of the matrix. Intersections of rows and columns represent binary choices between programs. The choices involve marginal utility and are made under the degenerate situation of maxim one (maximize objectives for given resources) mentioned earlier. If the row item is preferred over the column item a "+" is to be put in the cell. If the column item is preferred over the row item a "-" is to be put in the cell. The major diagonal would be filled with zeroes. If the superintendent is completely consistent one row will be filled with all plusses except for one zero. This, of course, is the preferred program. If the superintendent is inconsistent there may be minuses in every row. He must then either decide on a consistent set of choices or simply accept the row with the greatest number of plusses. (If a committee using the majority vote approach tries to establish the matrix it is well known that their choices can be inconsistent, that is, intransitive, with no means of remedying the situation.)

After setting up the first matrix and determining the preferred program the superintendent can set up another matrix in the same fashion, less the preferred program which has been chosen for the budget, and make a second choice. The process can be continued until all the discretionary funds have been allotted. If it is possible, a segment of the funds from each established program that has not been augmented should be removed for consideration. If the decisions embodied in the matrix indicate that the money should be returned to the same established program, that is fine. If a better use is found for the funds, that is fine too.

Two comments can be made on the method. First, many of the choices exhibited in the original matrix may be repeated in later matrices. Frequently the choice will be unchanged if the programs are independent; the choices will change greatly if the programs are dependent. If two or more programs serve the same function and one of the programs is selected to be included in the budget, then the remaining programs will have reduced utilities. (The change in choices as a series of matrices is developed reflects the changes of the slopes of the indifference curves as the budget margin changes.) Second, the programs used to form the matrices may represent either large systems or small projects. The Department of Defense under Hitch had about eight or nine "Major Programs" that included about one thousand "program elements." A school district might have thirteen programs based on grade levels, or half a dozen programs based on primary, elementary, etc., divisions, or as many programs as there are schools and other operating units in the district.

CHAPTER V

COST-EFFECTIVENESS ANALYSIS OF SELECTED VOCATIONAL-TECHNICAL PROGRAMS

Vocational-Technical Education in Florida

Area vocational-technical schools prepare people for entry employment or new employment as present occupations become obsolete, prepare for advancement in an occupation, and meet special student occupational education needs. Instruction is also provided in general and related education for adults at the elementary and high school levels.

The purpose of the area vocational, technical, and general adult programs in a single county or a group of adjoining counties constituting the center's service area is to serve high school students, high school graduates, out-of-school youth, and adults. The area centers are designated by the State Board for Vocational Education and administered by the county school board or the Junior College Board, depending on the location of the facility. The State Department of Education continues to expand the area vocational-technical centers both in number and size in terms of student stations needed.

There is an output deficit of approximately 145,000 trained workers now, and this number is projected to remain constant through 1973. The employment demands projected are being met by an output of only 36 per cent of the demand. The expansion plans proposed will increase the output so that the output is anticipated to increase to 47 per cent of the labor demand by 1973.[1]

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[1] State Department of Education, Projected Program of The Florida State Board for Vocational Education for the Fiscal Year 1968-69 (Tallahassee, Florida: Vocational, Technical, and Adult Education, Bulletin 70E-15A, May, 1968).

Further implications for continued expansion are shown by the enrollment trends of high school students. Projection estimates of enrollment of secondary students in vocational courses show that, by 1975, 55 per cent of secondary enrollment will be in some kind of vocational technical education or training. A second estimate involving total enrollment in vocational technical education projected by current trends shows an increase of 55 per cent by 1973.[1]

Florida's vocational educators also have the task of meeting the demands of local markets. These demands "are a part of the national labor force estimated to increase 13 per cent by 1970."[2]

In recent years vocational and technical education have received more than a cursory examination. Both the members of the vocational and technical education profession and other interested educators have entered into the debate of its value to both the individual and society. The key to answering the questions raised can be found at the local level of operation. At this focal point, educational input varies in both quality and quanity. It is this variance that compels investigations to determine what is being accomplished through vocational and technical curriculum.

The trend toward placing vocational-technical and commercial training in the years beyond the secondary school seems to be unmistakably sound. Today there are still many levels of technical education, and perhaps some of the lower levels will continue to provide training for business and commerce as long as graduates can be placed. If it becomes a truism that job opportunities no longer exist for high school graduates of technical and clerical programs, the role the high school should play would be that of appropriate pre-technical and pre-business training, laying the foundations for effective specialized study in the junior colleges.

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[1] Ibid.

[2] Carl W. Proehl, Then, Now and Tomorrow (Tallahassee, Florida: State Department of Education, Division of Vocational, Technical and Adult Education, 1966).

There is no doubt that education has contributed and will continue to contribute to economic growth by creating a labor force that is highly skilled and more adaptable to the needs of a changing economy. The level of formal education among the U.S. labor force has been sizeable. In 1952, the male labor force age 18-64 averaged (a median of) 10.6 years of formal education, and by 1962, 12.1 years.[1] There is reason to believe that the educational investments embodied in the labor force will be rising even more rapidly to perhaps 13 or 14 years between 1968 and 1970.

Still, the growth of expenditures on education continues. Public education expenditures in the U.S. climbed above $32 billion in 1967, from $10 billion only a decade earlier.[2] And, since 1900, total expenditures on education in the United States have increased four times as rapidly as total expenditures on physical plant and equipment. In 1900, education expenditures were only 9 per cent of investment in plant and equipment, but by 1956, they were 34 per cent,[3] and climbed to 37 per cent in 1966.[4]

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[1] U.S. Department of Labor, Educational Attainment of Workers, March, 1962, Special Labor Force Report No. 30 (Washington, D. C.: Government Printing Office, 1963), p. A-5.

[2] U.S. Department of Health, Education, and Welfare, Projections of Educational Statistics (Washington, D.C.: Government Printing Office, 1968), p. 61.

[3] T. W. Schultz, "Capital Formation by Education," Journal of Political Economy, LXVIII (December, 1960), 583.

[4] Burton A. Weisbrod, "Investing in Human Capital," The Journal of Human Resource, I, No. 1 (Summer, 1966), 11.

Some Comments on the Returns from Education

That there is a direct relationship between quality of education offered in a state and the rate of economic growth of that state suggests that economic growth can be accelerated by means of an improvement of the educational system. Educators are aware that choices have to be made which recognize the benefits and costs of alternative uses of available resources.

Two direct economic gains from schooling and training are: greater incomes (lifetime earnings), and smaller unemployment rates. Numerous studies, conducted under varying economic conditions, have shown that persons with more schooling tend to earn more money.[1] The studies support the thesis that investment in education provides, on the average, a favorable return when compared with other investment yields. Estimates by Becker show that education is an investment which produces at least as great a financial return as does investment in corporate enterprise--around 10 per cent for college, and even more for high school and elementary school.[2]

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[1] This implies a causal relationship between education and income. However, there are other variables which are causally related to income received. These include items such as ability, social standing, race, etc. There is little question that schooling and those variables converge to determine the final product and that considerable differentials exist between individuals. In general, the available evidence indicates that schooling and ability are complementary. In the aggregate sense, the mean income of individuals in the United States increases as the level of education attained increases.

[2] Estimates by G. S. Becker, as reported in T. W. Schultz, "Education and Economic Growth," in Social Forces Influencing American Education (Chicago, Illinois: National Society for the Study of Education, 1961), p. 78.

The social returns which accrue to a society include education's intergeneration benefits.[1] Educated citizens are more likely to raise children who recognize the value of education. Focusing on broad social benefits, Denison estimated that 21 per cent of the growth of real national income per person employed between 1929 and 1957 was attributable to greater education of the labor force, while another 36 per cent was attributable to the "advance of knowledge," much of which is associated with educational advance.[2]

Benefits that are derived from schooling in vocational-technical education are the same, basically, as those from any other education and/or training program. These benefits are both monetary and nonmonetary in nature.

The monetary benefits may be classed as both direct and indirect. The direct benefits or changes in the income streams of the workers receiving the schooling are the ones most easily identified. Wiseman says, ". . . it is conceptually possible to discover the 'gain' that an individual obtains from some specified type of education by comparing the changes in his income stream that result from the education with the costs that he must incur in order to obtain it."[3]

The following discussion by Weisbrod, while broad, is pertinent for all aspects of benefits:

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[1] W. J. Swift and B. A. Weisbrod, "On the Monetary Value of Education's Intergeneration Benefits," Journal of Political Economy, LXXIII (December 1965), 643-649.

[2] Edward F. Denison, The Sources of Economic Growth in the United States and the Alternatives Before Us. (New York: Committee for Economic Development, 1962).

[3] Jack Wiseman, "Cost-Benefit Analysis in Education," The Southern Economic Journal, XXXII, No. 1, Part 2, Supplement (July, 1965), 3.

> . . . a "benefit" of education will refer to anything that pushes outward the utility possibility function for the society. Included would be (1) anything which increases production possibilities, such as increased labor productivity; (2) anything which reduces costs and thereby makes resources available for more productive uses, such as increased employment opportunities which may release resources from law enforcement by cutting crime rates; and (3) anything which increases welfare possibilities directly, such as development of public-spiritedness or social consciousness of one's neighbor. Anything which merely alters relative prices without affecting total utility opportunities for the group under consideration will not be deemed a social benefit.[1]

This report concerns itself mainly with benefits of education (or returns from education) which are realized directly by the student. One form of such benefits is the "financial return" accompanying additional education. A second form is the "financial option" return, previously unconsidered, which involves the value of the opportunity to obtain still further education. Third are the nonmonetary "opportunity options," involving the broadened individual employment choices which education permits. Fourth are the opportunities for "hedging" against the vicissitudes of technological change; and fifth are the "non-market benefits."

These are the same benefits that Wiseman refers to as "psychic" returns (non-monetary) from education. He states;

> . . . while "psychic returns" associated with any kind of resource-use are difficult to evaluate, there are special problems in the case of education (and other "human investments") that complicate the question [further]. In the first place, there is a fundamental fashion in which the two types of psychic return differ in character. A man may obtain a "psychic" (consumption) return from "running his own business," or from owning land. In such

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[1] Burton A. Weisbrod, "Education and Investment in Human Capital," The Journal of Political Economy, LXX, Supplement (October, 1962), 108.

cases, we can distinguish the source of the return, and identify the time-period over which it accrues (the period of control of the business or ownership of the land). In the case of education, it has already been pointed out that the education process is not indivisible and also that the "asset" cannot be separated from the consumer of its services.[1]

"Consumption" of education is divided into at least two forms. The enjoyment that may be obtained from the "education process" during that time being educated, which, as an on-going process, improves the individual's expectations of higher future earnings, and the "psychic returns," obtained from the education when achieved, but enjoyed during the entire life span of the individual. Generally, it is believed that both types of returns are relevant, and it is frequently suggested that they can be separated by establishing the first as a form of current consumption and the second as a "durable goods" investment. The separation of these two is, however, somewhat controversial and the point will not be pressed.

With the changes in the availability of vocational-technical education (being more available at the high school level), students now are able, in some areas, to choose vocational-technical at the high school or post-high school level. Much thought, therefore, must be given to making the right decision because in some areas of work, for example the building trades, there is no noticable advantage to post-secondary training.

From his study Corazzini shows that:

> . . . the average starting wage for post-high school graduates who took one of the eleven trade courses offered high school students was \$1.84 per hour; the average starting wage for the vocational high school graduates was \$1.76 per hour. Hence, over-all, the average premium paid post-high school graduates was a mere 8¢ per hour, \$3.20 per week, or \$160 annually.[2]

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[1] Wiseman, op. cit., pp. 3-4.

[2] Corrazzini, op. cit.

Therefore, it would seem that this type of training has few, if any, benefits in terms of the two years of foregone earnings. However, the picture is different in trades that require a high school education before enrolling in the training program.

A discussion of investing in vocational-technical education would be incomplete if one did not mention major conditions which account for much, but not all, of the squandering of human resource capital. The first waste of human manpower arises when the community fails to invest adequately in the education and training of people. The result is that a great number of individuals fail to develop their full potentialities. Thus, their productivity in later years is far below what it could have been had they received better preparation. The second waste arises when individuals are unable to find a satisfactory, productive job in their community that pays at least the minimum wage prescribed by Federal or state law. And the third condition -- arbitrary barriers to employment -- reflects imperfections in the market. That is to say, educated labor is employed in jobs where the contribution is less than it would be if the men were able to move where there is greater need for their particular skills.

There are two remaining considerations to be mentioned. As technological changes and innovations such as automation become more complex, retraining of the unemployed will be a paramount problem. Thus, vocational-technical education can contribute enormously to economic growth by meeting the needs for flexibility and adaptability. It should not be overlooked that schooling, which appears today to be of direct vocational value, may not only be obsolete in future years, but its narrowness may create unforeseen obstacles in the adjusting mechanism to future manpower demands.

The Sample

School A

This school is located in Northern Florida. It is coeducational and provides vocational and technical training for high school students and adults in a wide variety of offerings.

Juniors and seniors enrolled in any of the six high schools in adjacent counties may attend the school. Students spend either the morning or afternoon in their own high school and a two or three hour block at the vocational-technical school. Bus transportation is provided. The courses are designed so that they will be completed at the time the high school students graduate providing them with a salable skill or trade when they seek employment.

Adults and out-of-school youths may enroll in any of the day courses along with high school students. In addition several evening courses are offered.

For admission students must have the ability, aptitude and interest needed to master the skills and knowledge required in the chosen occupation. The school has a full time vocational guidance counselor who will work with students with their course selection.

The school accepts as one of its responsibilities to assist the student in satisfactory job placement upon completion of preparation for employment. There is no tuition; however, a small materials fee is charged and will vary with the different courses.

The basic structure of the curriculum is such that high school students will finish their work in four semesters. However, returning veterans and other adult students may double up and finish in two semesters or one year.

A. Student Personnel Services

Student personnel services are available that meet the diverse needs of the students. These include individual appraisal of students' abilities and interests, educational-vocational, and personal counseling.

B. Information About Occupations and Employment Opportunities

The programs offered at the vocational-technical school meet the requirements of the Veterans Administration for eligible veterans to receive training under the current GI bills.

The school also cooperates with other governmental agencies for MDTA and vocational rehabilitation training for selected individuals.

C. Student Placement Service

Placement service is available for those seeking part time employment while in training as well as full time employment after their training is completed.

The school does not guarantee employment, however, the instructors and guidance counselor work closely together in assisting each student find employment suitable for the training received.

D. Description of Selected Course Offerings

a) Air conditioning and refrigeration.
The students are trained in this technology to be successful in trouble shooting, installation and service maintenance on all kinds of refrigeration and air conditioning equipment.

The current enrollment in this course is ten secondary, five post-secondary adults, and five post-secondary veterans. The laboratory is equipped with the latest equipment for testing, monitoring and servicing. The course requirement is 1400 hours of class and lab instruction. Live work is included in the laboratory instruction.

b) Auto Body and Fender Repair
This course teaches the art of repairing damages and of restoring the original beauty of automobiles. To do this the student is taught the characteristics of metals, auto body construction, shop operations and estimating, hammer and dolly work, welding, soldering, painting and glass replacement. The classroom has modern, up-to-date visual aids and the laboratory has all the latest models of hand and power tools, testing, and monitoring equipment. The total course requirement includes 1080 hours of class instruction and lab work with part of it being live work jobs.

c) Auto Mechanics

Instruction in this course includes overhaul and maintenance of automotive engines, transmissions, brake and cooling systems, engine tune-up and trouble-shooting. Graduates may enter the work field as beginning general mechanic. Part time specialized training will be available after completion of the general course. The classroom and shop are equipped with the latest equipment in hand and power tools including a baking room for paint jobs. The current enrollment is thirty-one secondary students, two post-secondary adults and three veterans.

d) Cosmetology

This course completely prepares the student for taking the State Board of Cosmetology examination by providing him or her with training in hair cutting, shampooing, dyeing, tinting and hair styling, manicuring and pedicuring, scalp treatment, and facial makeup and massage.

The class and laboratory including live work requires 1220 hours. The laboratory and classrooms are equipped with the latest in modern equipment and facilities. The present enrollment is fifteen secondary and thirteen post-secondary students.

e) Drafting

This course offers training in basic drafting techniques, architectural drawings, map drawings, and structural drawings. In short, the student learns to make accurate working plans and detailed drawings from rough sketches or notes for engineering or manufacturing purposes. The course requires 1080 hours and the work entry level is beginning draftsman. The current enrollment is fourteen secondary and six post-secondary students.

f) Distributive Education

The course will provide training in the fields of merchandising, marketing, sales and advertising. Some of the students are cooperative, on-the-job training students and their laboratory is live work. Training can lead to highly desirable positions in the many different retail and wholesale businesses. Graduates should be excellent prospective managers and department heads trainees sought by many large retail and wholesale establishments.

The enrollment currently is thirty-five students, all secondary. Fifteen of these are "co-op" students with one hour of class and two hours on-the-job training each day.

g) Farm Machinery Repair

This course will prepare the student for entry level employment in the repair and maintenance of tractors and other farm machinery and equipment. The program will include arc and acetylene welding, small gasoline engines, gas, L.P. and diesel tractor engines, and basic electrics and hydraulics. The classroom and laboratory are equipped with the latest, most modern hand and power tools, testing and monitoring equipment. Most of the laboratory work is live repair jobs. The course hour requirements is 1080. The current enrollment is twenty-two secondary and two veteran students.

h) Radio and T.V. Repair

This course trains radio and TV repairmen to install, maintain and service AM-FM radios, transitorized radios, and both color and black and white television sets. The course requirements are 1080 hours of class and laboratory. The advanced students will get experience on live work. The current enrollment is four secondary and five post-secondary students.

i) Small Gas Engine Repair

This course of instruction includes overhaul and maintenance of small gas engines. The program includes live work on pumps, chain saws, outboard motors, and auxillary power plants. The course requirement is 1080 hours of classroom and shop instruction. The current enrollment is thirty three secondary and two veterans as students.

School B

This school is located in central Florida in a metropolitan type area.

A. General Information

The school is a public, two-year co-educational institute above the high school level offering an occupational curricula in the fields of applied sciences and basic industrial, vocational, and technical areas.

The emphasis in all cases is on the application of knowledge. While education for immediate employment is the most essential goal, another important goal is to develop a potential for growth and change.

The program is planned to enable students to develop the skill, knowledge and desirable habits and attitudes essential to securing a job, holding a job, and gaining promotion in industrial organizations. Identification of these skills, knowledges, and habits is made possible through close cooperation with industrial personnel who are aware of the present and future needs.

Many of the courses offered in evening school are parallel and equivalent to those offered in the day school program. The evening school program is coordinated with the day program so that students may move in either direction when employment changes or other situations develop which force the student to withdraw from either program.

B. Description of Selected Program Offerings

a) Electronics Technology

Educational Objectives. To prepare the student for an entry job in the Electronics field. Graduates are trained to enter the broad fields of communications, radar, microwave, computers or industrial electronic control.

Nature of Work. An Electronics Technician is one who, in support of and under the direction of professional engineers or scientists, can carry out in a responsible manner either proven techniques, which are common knowledge among those who are technically expert in the technology, or those techniques especially prescribed by professional engineers.

Performance as an Electronics Technician requires the application of principles, methods, and techniques appropriate to the field combined with practical knowledge of the construction, application, properties, operation, and limitations of engineering systems, processes, structures, machinery, devices or materials, and, as required, related manual crafts.

Under professional direction, an Electronics Technician analyzes and solves technological problems; prepares formal reports on experiments, tests, and other similar projects; or carries out functions such as installation, maintenance, technical sales, advising consumers, technical writing, teaching, or training.

b) Radio and Television Service Specialist

Educational Objectives. The school is interested in training students for quality radio and television service work and to supply the radio and television industry with skilled employees.

Nature of Work. A Radio and Television specialist is largely self-sufficient and will often be self-employed. He may be required to read and operate signal test and substitution units, diagnose malfunctioning electronic equipment, and devise substitute or improvise electronic methods to obtain normal operation of field equipments, home and commercial radios and televisions.

TABLE 2

COMPARISON OF SCHOOLS A AND B

SCHOOL A	SCHOOL B
ADMISSIONS	
1. High School Students (grades 11 and 12) 2. High School graduates 3. Adults	1. High School graduates 2. Non high school graduates at least 18 years old and making qualifying scores on placement tests 3. Adults (qualified)
FEES	
1. No registration fee 2. No tuition fee 3. No book fee, a small materials fee is charged.	1. Registration fee $5.00 2. Tuition: $1.00 per hour of class attended per week up $20.00 per semester 3. Books and materials - vary by technology $25 to $40 per semester
TRANSPORTATION	
1. Buses are furnished from high school to vocational technical center and back to high school for high school students only.	1. No transportation provided.
LOCATION	
1. Rural area	1. Urban area

Anatomy of A Cost-Effectiveness Analysis

In both school systems the following accounts were utilized:

Account Number	Account Title
300	SYSTEM WIDE ADMINISTRATION
400	AREA ADMINISTRATION
410	Certified Personnel
420	Travel
430	Administration, Materials & Supplies
440	Furniture and Equipment
499	Other
500	SALARIES
510	Certified Personnel
520	Non-certified Personnel
530	Retirement Contributions
540	F.I.C.A. Taxes
550	Life Insurance Contributions
599	Other
600	CONTRACTUAL SERVICES
610	Meetings and General Travel
620	Communications
630	Printing and Reproduction Services
640	Repairs and Maintenance
660	Utilities
670	Rentals
680	Insurance
699	Other
700	MATERIALS AND SUPPLIES
710	Educational Materials and Supplies
730	Building Maintenance Materials & Supplies
750	Landscape Materials and Supplies

Account Number	Account Title
800	INTERNAL ACCOUNTS
900	CAPITAL OUTLAY
910	Educational Furniture
920	Educational Equipment
940	Maintenance Equipment
950	Vehicles
960	Library Books and Films
970	Buildings
980	Fixed Equipment in Buildings
999	Other

An example of the Cost-Effectiveness Working Schedule developed by the researchers is shown below.

Account Number	
510	Collect direct salary costs
510	Proportion costs on a per pupil basis by course
910, 920	Collect physical inventory data and depreciate
910, 920	Calculate per item depreciation
910, 920	Determine classroom utilization
910, 920	Proportion costs on a per pupil basis by course
970	Collect building cost and depreciate by term
970	Proportion depreciation to classroom area
970	Proportion depreciation on a per pupil basis by course
300, 410 420, 430 499, 520 530, 540 550, 599 600 Series 700 Series 800, 940 950, 960 980, 999	Proportion indirect costs on a per pupil per term basis
All Accounts	Summary of program course costs per pupil

Part I: Costs

Part I of the cost-effectiveness strategy consisted of the following steps:

A. Program and student data from a variety of courses were entered on Program Data Sheets. (See Table 3.)

B. Student Data were collected for each student in specified vocational-technical education courses. (See Table 4.)

C. Simultaneously with collecting student data in School A and School B, direct and indirect costs were calculated.

The three major steps involved were:

1. collection of direct salary costs and retirement contributions;
2. calculating indirect costs on a per pupil basis (See Table 6);
3. proportioning costs on a per pupil basis per course (See Tables 5 and 6).

D. At this point of the investigation it was decided to limit further detailed research to two program areas only because an evaluation of data[1] collected in School A and School B showed that information

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[1] Data were collected in the following areas: Cosmetology, Distributive Education, Auto Body & Fender Repair, Auto Mechanics, Horticulture, Farm Machinery Repair, Electronics, Radio & TV Repair, and Office Education.

TABLE 3: PROGRAM DATA SHEET (SAMPLE)

COURSE OF STUDY: Farm Machinery	Class Hrs Per Week	Lab Hrs Per Week	Hrs Total	Instructor
Course Outline				
1. Introduction	3			
2. Safety	4	3	7	
3. Tools & Equipment	30	50	80	
4. Welding	40	160	200	
5. Small gasoline engines	30	70	100	
6. Hydraulics	10	20	30	
7. Electrical Systems	10	50	60	
8. Power Trains	20	40	60	
9. Gasoline Engines	40	160	200	
10. Diesel Engines	5	45	50	
11. Tractors	50	150	200	
12. Farm & Equipment	10	80	90	
			1080 Hrs	

Number Graduated ___--___

Number Enrolled ___24___

Number of Students:

_2_ 1. Veterans

_-_ 2. Post-Secondary

_22_ 3. Secondary

_3_ 4. With Previous work exp.

TABLE 4: STUDENT DATA SHEET (SAMPLE)

STUDENT DATA SHEET

COURSE OF STUDY: Auto Body & Fender	Class Hrs Per week	Lab Hrs Per week	Dates Given	In-structor
	5	5	Fall 67	Miller

Student Name Joe Smith

Date of Graduation June 1968

Race W Sex M

Birthdate 7-19-49

IQ 96 IQ Test Otis

Student Classification: Check one

____1. Veteran

X 2. Post-Secondary

____3. Secondary

EMPLOYMENT DATA:

Previous employment experience

____yes; X no;

Current Employment:

Company Chrysler Plant

Location Detroit, Michigan

Position Title Welder (II)

Time Between Grad. & emp. 0

Pay Entry Level $95/week

Number of Applications 1

Employed in Area of Training Yes

TABLE 5: SUMMARY OF DIRECT COURSE COSTS PER PUPIL

	Account Numbers			
	510	530 @ 6.5%	910	970
ELECTRONICS I	98.46	6.40	6.39	7.33
ELECTRONICS II	133.64	8.69	12.38	6.39
ELECTRONICS III	156.60	10.18	38.37	13.84
ELECTRONICS IV	112.78	7.33	48.65	8.57
ELECTRONICS V				
ELECTRONICS VI				
ELECT INSTRUM I	36.69	2.38	17.48	3.08
ELECT INSTRUM II				
ELECTRICAL DRAFT	75.45	4.90	1.38	2.99
BLUEPRINT READ				
MECH. DRAW I	68.74	4.47	1.32	2.86
MACH SHOP PRACT	124.67	8.10	1.47	9.94
SHEET MET FAB	52.53	3.41	2.20	2.23
TECH COMM I	48.75	3.17	3.17	1.78
TECH COMM II				
BASIC ELECTRICITY	85.50	5.56	23.69	6.31
ELEM OF ELECTRON				
PRODUCTION TECH				
COST CONTROL				
HUMAN RELATIONS	84.62	5.50	.61	4.43
APPLIED MATH I	77.27	5.02	.34	2.45
APPLIED MATH II	59.98	3.90	.20	2.20
APPLIED MATH III	35.70	2.32	12.16	2.14
INDUST MATERIALS	29.00	1.89	2.21	1.63
APPLIED PHYSICS I	43.18	2.81	3.63	2.68
APP PHYSICS II	125.83	8.19	8.48	6.26
APP PHYSICS III				
APPLIED CHEM.	50.79	3.30	3.63	2.68

TABLE 6: SUMMARY OF INDIRECT COURSE COSTS PER PUPIL

ACCOUNT NUMBER	TERM COST	TOTAL TERM COST
300	5.05	
410	15.42	
420	.31	
430		
440	1.78	
520	31.98	
540	1.41	
500		
620	2.55	
630	.26	
640	1.68	
660	14.88	
680		
699	1.25	
600		
710	8.93	
730	2.27	
799		
700		
800	26.76	
960	.80	
900		
Total Per Pupil		115.33

was most complete and most accurate in only two programs--Electronics and Radio & TV Repair--where longitudinal data dating back to 1965 (School B) could be gathered.

The following tables indicate that there are no short-cuts possible in cost-effectiveness analysis, and that detailed research is unavoidable.

E. The next steps involved:

1. collecting physical inventory data and depreciate;
2. calculating per item depreciation;
3. determining classroom utilization;
4. proportioning item costs on a per pupil basis per course.

Tables 7, 8, and 9, illustrate clearly the various steps involved.

F. The next items to be calculated and entered (see Table 9) were:

1. collecting building costs and depreciate by term;
2. proportioning depreciation to classroom area;
3. proportioning depreciation on a per pupil basis per course
4. proportioning indirect costs (see Table 6) on a per pupil basis per term basis;
5. summarizing all program course costs;
6. entering starting salary for graduates (See Table 9).

TABLE 7: PROGRAM SUMMARY SHEET (SAMPLE) RADIO & TV REPAIR
1968 Graduate

Course Title	Account Numbers 510 530	910	970	Ind. Cost	Total Cost	Dates Taken	In-structor	Term
Radio-TV I	453.90	15.99	15.90	113.69	599.48	9/67-1/68	Miller	3-67
Radio-TV II	376.30	12.93	12.51	115.33	517.07	1/68-6/68	"	2-68
Radio-TV III	297.14	47.83	21.71	154.46	521.14	6/68-8/68	"	3-68
Math I	51.39	1.93	2.10	--	55.42	9/67-1/68	"	1-68
Math II	63.88	.20	2.20	--	66.28	1/68-6/68	"	2-68
Total	1242.61	78.88	54.42	383.48	1759.39			

STUDENT DATA SHEET

Student No. 3933 Program RS

IQ 96 IQ Test Otis

Date of Graduation 8-68

Race W Sex M Birthdate 12-9-48

EMPLOYMENT DATA:

Company G.E. Laboratory

Position Title Electronic Repairman

Time between grad. & emp. --

Pay Entry Level $2.20/hr.

Number of applications 1

TABLE 8: PROGRAM SUMMARY SHEET (SAMPLE) RADIO & TV REPAIR
1967 Graduates

Course Title	Account Numbers 510 530	910	970	Ind. Cost	Total Cost	Dates Taken	In-structor	Term
Radio-TV I	389.79	25.66	8.39	117.31	541.15			1-66
Radio-TV II	306.90	60.34	1.51	114.05	482.80			2-67
Radio-TV III	297.14	47.83	21.71	154.46	521.14			3-67
Math I	77.98	.37	2.93	--	81.28			1-66
Math II	37.58	.39	2.97	--	40.94			2-67
(NE)[1] Total	1109.39	134.59	37.51	385.82	1667.31			
(E)[2]	15.00	3.00	1.00	23.00	42.00			
TOTAL	1124.39	137.59	38.51	408.82	1709.31			

[1] NE - Students with no previous work experience

[2] E - Students with previous work experience

TABLE 9: SUMMARY OF COSTS - RADIO & TV REPAIR
1968 and 1967 Graduates

Student #		Account Number			Ind. Cost	Total Cost	# of Courses	# of Terms	Starting Salary
		510 530	910	970					
2932		1242.61	78.88	54.42	383.48	1759.39	6	3	4400.00
2959		1242.61	78.88	54.42	383.48	1759.39	5	2	4600.00
(NE) N=2	Mean =	1242.61	78.88	54.42	383.48	1759.39	5.5	2.5	4500.00
2650		1173.13	77.39	57.32	539.94	1854.78	5	4	4000.00
2750		1206.19	99.07	53.36	382.20	1740.82	5	3	4750.00
2745		1242.61	78.88	54.42	383.48	1759.39	5	3	*10000.00
2890		1242.61	78.88	54.42	383.48	1759.39	6	3	4000.00
2969		1242.61	78.88	54.42	383.48	1759.39	5	3	Piece work
2970		1242.61	78.88	54.42	383.48	1759.39	5	3	4400.00
4029		1242.61	78.88	54.42	383.48	1759.39	5	3	4500.00
		8592.37	570.86	382.78	2839.54	12392.55			
(E) N=7	Mean =	1228.00	82.00	55.00	406.00	1770.00	5	3	Md=4400.00

*Self-employed

N=9 (1967 Graduates)

Md=4052 - (est.-7.9%)

Part II: Utility

Part II of the cost-effectiveness strategy consisted of the following steps:

A. Private costs of education were calculated for 1967 and 1968 graduates (see Table 10) for foregone earnings (see Table 12), while marginal public utilities are shown in Tables 11 and 13.

B. In Table 14, summary results of the calculations described in the preceeding pages for private and public rates of return to investment in Radio & TV Repair programs are presented. And, finally, Table 16 shows private and public utility ratios (for Electronics programs) which have been offered at School B since 1965.[1]

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[1] In view of the limitations of the data, strong conclusions regarding "return to investment in vocational-technical education" should be treated with extreme caution. The author wants to emphasize (see also Chapter X, "Summary and Conclusions," of this report) that no neat weight can be attached to the particular private and public rates of return provided in Tables 14 and 16. They are, at best, illustrative. A far larger and more representative sample would be required before anything more decisive could be said about the magnitude of the private and public utility ratios.

TABLE 10: SUMMARY OF PRIVATE COSTS (RADIO & TV REPAIR)
1967-68 Graduates
(Dollars)

		Acct.#800 Internal Funds	Foregone Earnings	Fees	Books	Misc. Supplies	Total Private Costs
1968	NE	97	3463	60	95	52	3670
	E	97	3757	60	95	52	3964
1967	NE	108	3189	60	95	63	3407
	E	108	3460	60	95	63	3678

TABLE 11: SUMMARY OF PUBLIC UTILITY -- MARGIN
1967-68 Graduates (Radio & TV Repair)
(Dollars)

		Earnings	Federal Income Tax	State Sales Tax	Taxable Home Value	Real Estate Tax Millage	Real Estate Tax	Total Taxes
1968 NE	Earnings	4400	313	61	3131	29.49	92	466
	Foregone	3835	219	56	2087	29.49	62	337
	Margin	565	94	5	44	--	30	129
1968 E	Earnings	4400	313	61	3131	29.49	92	466
	Foregone	4162	289	58	2691	29.49	79	426
	Margin	238	24	3	440	--	13	40
1967 NE	Earnings	4052	256	40	2488	35.06	87	383
	Foregone	3463	166	36	1399	35.06	49	251
	Margin	589	90	4	89	--	38	132
1967 E	Earnings	4052	256	40	2488	35.06	87	383
	Foregone	3757	211	38	1943	35.06	68	317
	Margin	295	45	2	545	--	19	66

TABLE 13: FOREGONE EARNINGS (RADIO & TV REPAIR)
1967-68 Graduates
(Dollars)

	Percentage Factor[1]	Non-Experienced (NE)[2]	Experienced (E)[3]
August 1968	--	3463	3757
August 1967	7.9	3189	3460

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[1] Source: Age-Wage Survey, U.S. Dept. of Labor Bulletin No. 1625 - 10, August 1968, p. 4.

2 and 3: *Ibid*., p. 8.

TABLE 13: SUMMARY: PUBLIC UTILITY (RADIO & TV REPAIR)
1967-68 Graduates
(Dollars)

		Income	(Marg.Gain) Federal Income Tax	(Marg.Gain) State Sales Tax	Marginal County Real Estate Tax*	Total Marginal Gain-Tax
1968	NE	4400	94	5	30	129
	E	4400	24	3	13	40
1967	NE	4052	90	4	38	132
	E	4052	45	2	19	66

*Based on FHA Maximum Allowable for Income Level

TABLE 14: SUMMARY OF PRIVATE AND PUBLIC RATES OF RETURN TO INVESTMENT (RADIO & TV REPAIR PROGRAMS)
(Dollars)

		Teaching Salaries and Retire. Benefits	Furniture Equipment Deprec.	Building Space Deprec.	Ind. Cost	Total Cost	Total Public Cost C_2 *(-Acct.#800)	Total Private Cost C_1	Marginal Utility Private U_1	Marginal Utility Public U_2	Private Rate of Return	Public Rate of Return	C_1/U_1	C_2/U_2
											%	%		
1968 Graduates	NE	1243	79	54	383	1759	1662	3670	565	129	15.4	7.8	6.50	12.88
	E	1228	82	55	406	1771	1673	3964	238	40	6.0	2.4	16.66	41.83
1967 Graduates	NE	1109	135	37	386	1667	1559	3407	589	132	17.3	8.5	5.78	11.81
	E	1124	138	38	409	1709	1601	3678	295	66	8.0	4.1	12.47	24.26

*Acct. #800 - Internal Account

TABLE 15: PUBLIC UTILITY - MARGIN (ELECTRONICS PROGRAM)
(Dollars)

		Earnings	Federal Income Tax	State Sales Tax	Taxable Home Value	Real Estate Tax Millage	Real Estate Tax	Total Taxes
1968 NE	Earnings	6148	618	79	6362	29.16	186	883
	Foregone Earnings	3835	219	55	2087	29.16	61	335
	Public Utility U_2 (Unmarginal)	2313	399	24	4275	--	125	548
1968 E	Earnings	6993	768	87	7923	29.16	231	1086
	Foregone Earnings	4162	271	58	2691	29.16	78	407
	U_2	2831	497	29	5232	--	153	679
1967 NE	Earnings	5254	439	50	4710	35.06	165	654
	Foregone Earnings	3963	241	40	2324	35.06	81	362
	U_2	1791	198	10	2386	--	84	292
1967 E	Earnings	4820	374	47	3907	35.75	137	558
	Foregone Earnings	3757	211	38	1993	35.75	68	317
	U_2	1063	163	9	1914	--	69	241
1966 NE	Earnings	5132	421	49	4484	35.75	160	630
	Foregone Earnings	3189	123	33	894	35.75	32	188
	U_2	1943	298	16	3590	--	128	442
1966 E	Earnings	5066	411	49	4362	34.78	156	616
	Foregone Earnings	3460	166	36	1394	34.78	50	252
	U_2	1606	245	13	2968	--	106	364
1965 NE	Earnings	4800	374	46	3870	34.78	135	555
	Foregone Earnings	2998	96	32	1540	34.78	19	147
	U_2	1802	278	14	2330	--	116	408
1965 E	Earnings	4750	366	46	3778	34.78	131	543
	Foregone Earnings	3253	137	34	1011	34.78	35	206
	U_2	1497	229	12	2767	--	96	337

TABLE 16: PRIVATE AND PUBLIC RATES OF RETURN TO INVESTMENT IN ELECTRONICS PROGRAMS
(Dollars)

		Teaching Salaries and Retir. Benefits	Furniture Equipment Deprec.	Building Space Deprec.	Ind. Cost	Total Cost	Total Public Cost C_2 *(-Acct.#800)^2	Total Private Cost C_1	Marginal Utility Private U_1	Marginal Utility Public U_2	Private Rate of Return %	Public Rate of Return %	C_1/U_1	C_2/U_2
1968 Graduates	NE	1057	149	45	474	1725	1597	5815	2313	548	39.8	34.3	2.51	2.91
	E	1086	148	55	500	1789	1651	6758	2831	679	41.9	41.1	2.39	2.43
1967 Graduates	NE	1235	154	44	557	1990	1820	6568	1791	292	27.3	16.0	3.67	6.23
	E	1375	229	65	561	2230	2080	5918	1063	241	18.0	11.6	5.57	8.63
1966 Graduates	NE	1796	512	122	660	3090	2948	6201	1943	442	31.3	15.0	3.19	6.67
	E	1691	408	102	582	2783	2662	5803	1606	364	27.7	13.7	3.61	7.31
1965 Graduates	NE	1431	371	86	761	2649	2493	5956	1802	408	30.3	16.4	3.31	6.11
	E	1451	334	81	761	2627	2471	6432	1497	337	23.3	13.6	4.30	7.33

*Acct. #800 - Internal Account

Determination of Marginal Utility

Two aspects of utility were considered: (1) The utility of programs in terms of monetary return on investment to the public or society; and (2) private monetary returns to an individual graduate of the programs. In order to determine the marginal utility or "gain" for each sector, the investment (or expenditures) made by the public and the graduates was first determined.

Private Costs. The private costs to an individual or his family unit (C_1) was determined by

$$C_1 = E_1 + F + B + S$$

in which E_1 represents foregone earnings, F is the fees paid by the student, B is the cost of his books, and S is the cost of his miscellaneous supplies.

An estimate of the earnings a student foregoes while enrolled in the program is based on: (1) Mean hourly earnings of unskilled labor in general manufacturing for the metropolitan area served by School B for 1967-1968[1]; (2) extrapolating percents of increase in earnings for the five years previous to the Area Wage Survey[2] and inclusive in this study; and (3) computing the total foregone earnings for the mean time period (total number of school terms) a graduate would be enrolled at School B.

Student fees were obtained from School B's Catalog. Total fees for a student were calculated by multiplying the fee per school term times the mean number of school terms a student required to complete the program.

The cost of books and miscellaneous supplies was determined from records kept by the department head and the school's bookstore. It is assumed that the cost of traveling to and from School B is equal to the cost of traveling to and from a job.

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[1] See Table 13; page 90 of this report.

[2] Ibid., p. 8.

Public Costs. The total cost of the program to the public or society (C_2) was determined by

$$C_2 = C_{et} - I$$

in which C_{et} is the total Electronic Technician program cost, both public and private, as calculated in the previous section of this chapter, and I represents the "internal funds" (account number 800). The internal funds account reports funds received from student fees, profits on vending machines and other miscellaneous non-public sources of income.

Private Utility. The marginal utility of the program in terms of monetary return to an individual graduate (U_1) was calculated by

$$U_1 = C_1 - E_2$$

with C_1 representing the private costs of the program to the individual student as calculated above and E_2 representing the mean pay entry level of the graduate into the electronics manufacturing industry. This pay level was determined by calculating an arithmetic mean of the pay entry level wages recorded on the "Student Data Worksheet" (page 80).

Public Utility. The marginal public utility (U_2) in this report is based upon the monetary return of additional taxes paid by graduates as a result of their marginal income gain. This utility factor was calculated by

$$U_2 = F_i + S_s + R$$

in which:

1. F_i is the additional margin of Federal income tax paid by a graduate. These figures were obtained from the 1964--1968 "Federal Income Tax Tables" in the three dependents column. F_i represents the Federal income tax difference paid on earnings E_1 and E_2. (See Table 15).

2. S_s is the additional margin of Florida state sales tax paid by a graduate. These figures were obtained from the 1964--1968 "Federal Income Tax Tables." In these tables are listed approximations of sales taxes expended according to level of income. Florida sales taxes during 1964--1967 were at a rate of 3 percent and 1968 at 4 percent. (See Table 15).

3. R is the additional margin of County real estate tax paid by a graduate. These figures are based upon the assumption that a graduate, because of the significant increase in his earnings, could afford to purchase a home having a higher assessed value for tax purposes. The estimates of the value of a home a person with a given income could afford were obtained from the local Federal Housing Authority Office. Tax calculations were then made based on the real estate tax rates for the county in which School B is located. These rates were obtained from the County Tax Collector's records. (See Table 15).

Determination of Cost-Utility Ratios

The final sets of calculations in this report involve the computing of cost-utility ratios between: (1) Private costs and utility (CU_{pr}); and (2) Public costs and utility (CU_{pb}). The formulae used to determine these ratios were

$$(1) \qquad CU_{pr} = \frac{C_1}{U_1}$$

$$(2) \qquad CU_{pb} = \frac{C_2}{U_2}$$

The cost is C and the utility is U, so that the cost-utility ratio is C/U, there both the numerator and denominator are in dollars and are common to all other cost-utility ratios used in this system. (See Table 16).

The major variables found in individual course costs per pupil were due to:

1. The numbers of students completing a given course--the greater the number of students completing a given course or course section, the less course cost per pupil.

2. The cost per hour allocated to a given instructor for his direct teaching services varies directly with the salary experience step of the instructor and indirectly with the number of course hours per day assigned to the instructor for direct teaching.

3. Furniture, equipment, and space (facility) costs vary indirectly with the number of hours per day a given classroom or laboratory is utilized.

The major variables found in total program costs per pupil, in addition to the above individual course cost variables, included:

1. Program costs varied indirectly with the total number of courses (or credits) required to complete the program and thus the number of school terms required. The 1965 and 1966 non-experienced graduates required six trimester terms to complete their programs. The 1967 graduates required four trimester and two semester terms, and the 1968 graduates required four semester terms.

2. The organization of the school terms for a given school year into three trimesters of equal time periods (four months) or two semesters of five months each and a two month summer session. As only the 1968 graduates were products of the semester system an evaluation of the trimester vs. semester cost factors was not attempted Further data is needed on succeeding years of graduates to form significant conclusions on cost comparisons. However, it is noted that during the two-year period of the 1968 graduate's program, enrollments increased, and program length decreased by elimination of some required courses and expanding the course content of others to include material previously covered in the eliminated courses, which had the effect of decreasing costs per pupil in all expenditure categories.

Private Costs

The major private sector costs to an individual electronics technology student at School B consisted of: (1) earnings foregone by the student while attending School B; (2) fees; (3) books; and (4) miscellaneous incidental costs to the student.

In order to compute the total foregone earnings for a graduate of a given year, the following data was compiled: (1) The average (mean) annual wage of an unskilled manufacturing worker for each year 1964--1968; and (2) calculations of the total foregone earnings over the average time periods (number of school terms) required to complete the electronics technology program.

The total private costs of the program as reported in Table 16 is the sum of the four categories of costs listed above. These costs for the non-experienced stratum steadily increased from 1965 through 1967 mainly due to the steady increase in wage levels of foregone earnings during this period of time, as the time period needed to complete the program remained relatively constant. The 1968 graduate's costs decreased significantly due to program curriculum revisions which reduced the average number of months required to complete the program, thus reducing the time period calculation for foregone earnings which were offset only slightly by the increase in wage level of foregone earnings for the 1968 graduate.

Students classified as experienced indicated a wider variance of private costs influenced by both the variation in wage levels and the duration of enrollment with the latter having the greater affect with 1965 graduates and the former having the greater affect with the 1966--1968 graduates.

Public Costs

Table 16 represents the empirical average (mean) costs per pupil to the public or society of the Electronics program at School B. These costs include the total program cost less the "internal funds" account number 800. As noted earlier, the "internal funds" account records funds received from student fees and other sources classified as non-public.

The major cost variables that applied to total program costs also apply to the public costs. The 1965 and 1966 experienced graduates indicated lower public costs than the non-experienced because the former received equivalency credit for their work-experience or previous training and completed their program course requirements in a fewer number of school terms. This cost trend reversed with the 1967 and 1968 graduates as the experienced graduates included greater numbers of Korea and Viet Nam veterans receiving educational benefits. A large number of these veterans tended towards either taking more advanced courses--with higher course costs due to lower enrollments per course--or elected to take more courses than the minimum actually required to complete the program.

Private Utility

Among technical education's foremost tangible benefits to an individual student is the incremental margin of earnings between an estimate of what his earnings would have been without technical education at the same point in time as his first year of post-technical education and his actual earnings during the first year of his post-technical education employment. There are many nonquantifiable aspects embodied in the utility of any educational program which often may carry more weight than monetary aspects to an individual student.

The average (mean) marginal utility in monetary terms for an individual student in the non-experienced stratum is given in Table 11. The earnings of $3835 for the 1968 graduate, for example, represents the annual earnings the graduate would have earned if he had not entered School B's program and continued his employment as an unskilled manufacturing worker. These earnings are estimated on the same basis and were obtained from the same source as foregone earnings. The first year earnings reported in Table 11 and Table 15 are the empirical average annual earnings of the graduates as they entered the industry. The difference between these two earnings yields the marginal monetary utility of the program expressed in dollars.

The trend in marginal utility is consistent with other results in this study--that of increasing marginal utility from 1965--1968 with the exception of the transitional 1967 graduates.

Public Utility

In the previous section the additional income produced through enrollment and graduation from the Radio & TV Repair and Electronic Technician programs at School B was discussed. This income initially is a direct benefit which accrues to the individual graduate. Some of this private benefit, however, eventually accrues to society (the community) through taxation.

The findings reported in Table 15 are estimations of incremental margins of taxes paid by graduates based on their private marginal utility income increments. This marginal increment in taxes paid by the graduate represents the monetary utility or return to the public on its investment in technical education students enrolled in the electronics technology program at School B. Again, it is emphasized that this represents a perhaps modest aspect of the total utility of a given technical education program and intangible benefits to society which permit an educated person to participate more fully in society may carry more weight in determining relative utility of various educational programs.

As it can be seen from Table 15, the non-experienced graduate, (NE), for example, annually pays additional federal taxes of $399; state sales taxes of $24; and local real estate taxes of $125. This totals to an incremental margin of $548 greater than if taxes were computed on the earnings base of an unskilled manufacturing worker. The $548 is the value assigned to the monetary public utility of the program for the 1968 graduate.

Cost-Utility Ratios and Rates of Return

Private Rate of Return. The 1968 graduate (non-experienced) has invested approximately two years of foregone earnings and direct costs totaling $5815. (See Table 15). In return he received average earnings of $2313 greater than he would have had he continued as an unskilled manufacturing worker.

These two factors are used in the computation of a cost/utility ratio which yields a figure useful for comparison of the program's relative effectiveness over previous years and relative utility value, limited to the monetary aspect, with other educational programs. The 1968 graduate, as noted in Table 16, yields a cost-utility ratio of 2.51. This ratio number is also equivalent to the number of years it will take the graduate to receive a return of $5815 or "total return" on his investment. This rate of return assumes that the graduate has no further increases in earnings during the 2.5 year period following his graduation. Since this is a rather weak assumption in that the graduate will more likely receive pay raises during this time, the rate of return listed in Table 16 is probably conservative.

Because both the cost and utility factors are in the common units of dollars, the rates of return to the graduate on his investment are computed by simply taking the reciprocal of the cost/utility fraction. These rates of return are based on the first year earnings after graduation.

Public Rate of Return. The return to the public on its investment in School B's programs was also raised as a question for investigation in this study. The results of investigation are reported in Tables 14 and 16.

We see in Table 16 that the public (or society) invested $1597 over a period of two years in a 1968 graduate's (non-experienced) program at School B. For this investment the public received in the form of additional taxes paid by the graduate during his first year of employment $548. The cost-utility ratio indicates a period of less than three years in which the graduate will return society's investment of $1597, assuming that the graduate has no increase in earnings during this time period. Again this assumption being unlikely, it would be expected that the graduate will return the investment to the public in an even shorter period of time than reported in Tables 14 and 16. The public rate of return of 34.3% is also based on the first year earnings after graduation.

Calculating Present Income Values and the Rate of Return

One way of comparing the earnings streams resulting from different amounts and types of vocational-technical education is to look at their present values to one who leaves school at age twenty. The present value to a twenty-year-old of a promise of, for example, \$10,000 at age 60, is not \$10,000, but, rather, the sum which needs to be invested now at compound interest so as to accumulate \$10,000 in 40 years' time.

If \$x is invested now it will be worth $x(1 + i)^{40}$ at age 60, where i is the compound interest rate. Thus, if \$x is the present value of \$10,000 at age 60, one finds:

$$x(1 + i)^{40} = \$10,000 \quad \text{or } x = \frac{\$10,000}{(1 + i)^{40}}$$

More generally, an expected salary at age t (or S_t) has a present value, for a twenty-year-old, of:

$$x_t = \frac{S_t}{(1 + i)^{t-20}}$$

The present value (X) of the total salary stream between the present age of 20 and the age of retirement (e.g. 65) is the sum of the present value of each year's salary, that is:

$$X = \sum_{t=20}^{65} x_t = \sum_{t=20}^{65} \frac{S_t}{(1 + i)^{t-20}}$$

The costs of education (Y) can be calculated in the same way. If the cost at age t is C_t, and the present value of this cost is y_t, then:

$$Y = \sum_{t=20}^{65} y_t \quad = \quad \sum_{t=20}^{65} \frac{C_t}{(1 + i)^{t-20}}$$

C_t will be equal to zero when education has ceased. A combination of X and Y gives the present value of the future income stream (Z) net of educational costs; the stream will be negative during fulltime study, and may be positive or negative during part-time study.

$$Z = X - Y \quad \sum_{t=20}^{65} (x_t - y_t) = \sum_{t=20}^{65} \frac{S_t - C_t}{(1 + i)^{t-20}}$$

It is relatively easy to obtain an internal rate-of-return, i, which makes Z equal to zero--that discount rate which equates the present value of the costs and benefits. Such an interest rate can generally be calculated for any educational investment project. Consider the usual form of a non-discounted income stream as shown in Figure 7', which is initially negative and then becomes positive, i.e., which costs something and then yields returns.

The interest rate can be raised so high that the present value of any income after the first few years of employment practically disappears, leaving only the initial negative income; thus, at very high interest rates Z will be negative.

On the other hand, provided that the non-discounted returns exceed the costs over the lifetime of an investment, an interest rate of zero will yield a positive value for Z. Between these two extremes there will be some value of i (i*) which will set Z equal to zero. By means of graphical interpolation one can plot the value of Z against i. The curve of what might be called the net present value will generally be of the shape indicated

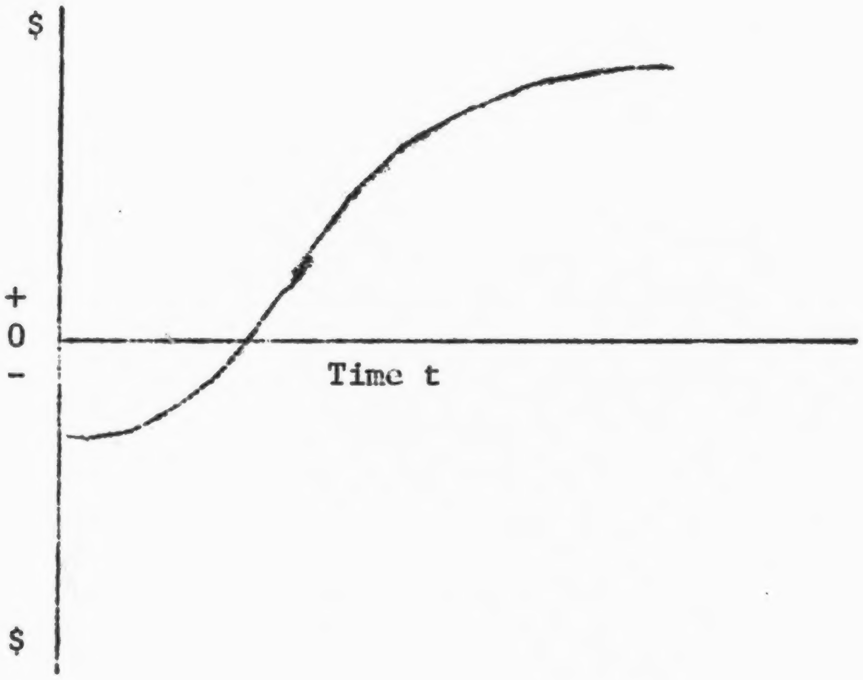


Figure 7 .--Non-Discounted Income Stream

in Figure 8, and the internal rate-of-return will be that value of i where the Z curve crosses the horizontal axis.

This graphical method is useful in making comparisons between income streams associated with different types of education and training, e.g. vocational-technical and general education. Figure 9 shows possible income streams for two different vocational-technical programs (Electronics Technology, and Radio and TV Repair). Figure 10 shows the current value of these two income streams plotted against i, and it can be seen that the value for Z for the two programs coincides for an interest rate of i*. In other words, theoretically it would be unprofitable for a youngster to aim for graduating in the Radio and TV Repair program rather than to graduate in Electronics Technology, if the interest rate was greater than i*.

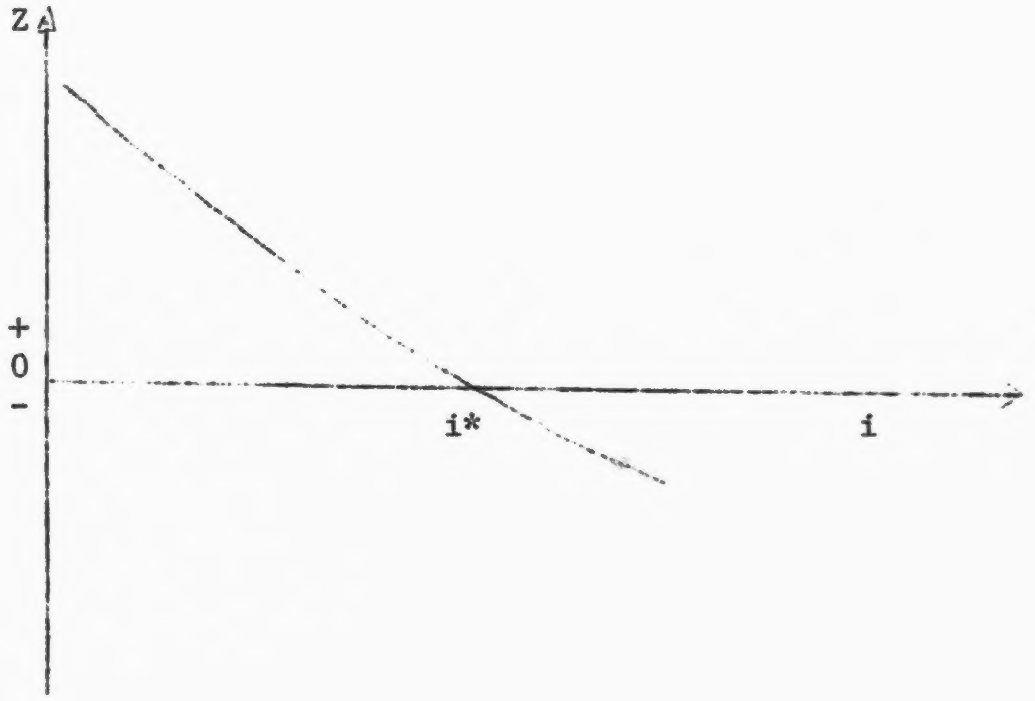


Figure 8 .--Curve of Net Present Value

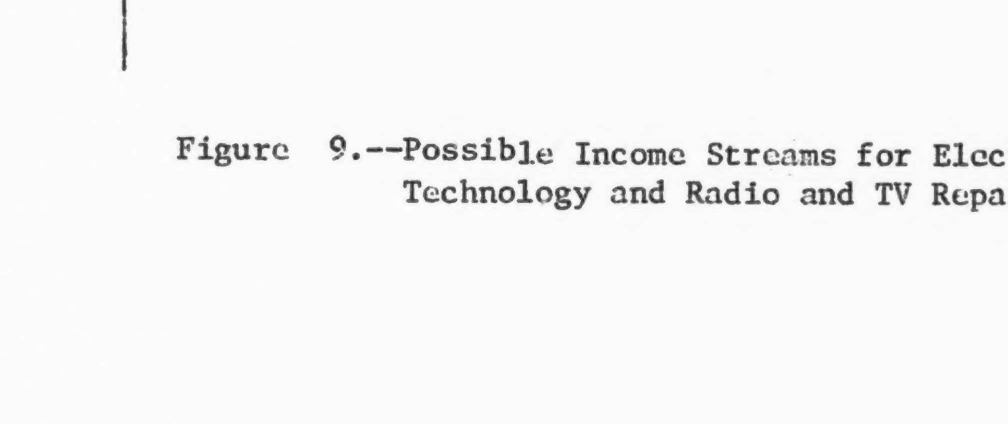


Figure 9.--Possible Income Streams for Electronics Technology and Radio and TV Repair Programs

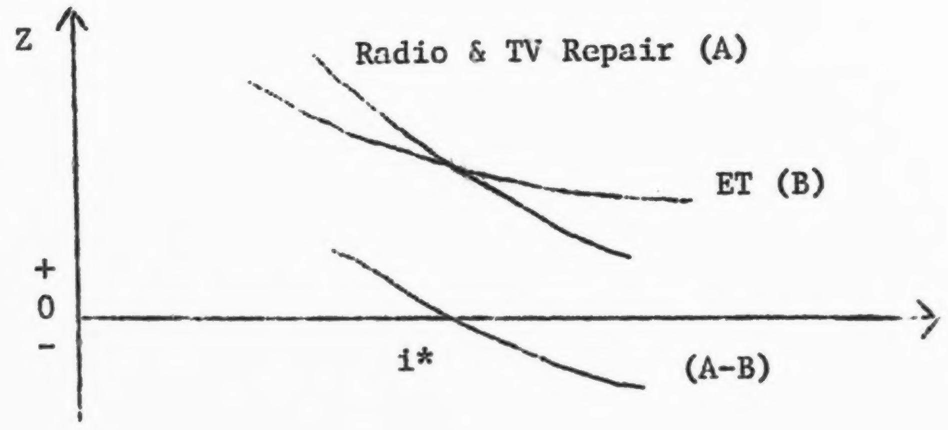


Figure 10:--Current Value of Income Streams for Electronics Technology and Radio & TV Repair Programs

In fact, of course, this pilot study is not concerned with longitudinal data of the lifetime earnings of graduates of area vocational-technical schools. What is available is cross-sectional data of different individuals who graduated during the last three years. The common procedure is to adopt these cross-sectional training-earnings profiles as proxy measures of the lifetime earnings patterns of given trained individuals, aging over time. The procedure is a familiar one, but perhaps a few words of caution are in order. Lifetime earnings streams estimated from cross-sectional data can differ from actual time series data for a number of reasons, the more important being: (a) business cycle effects, (b) the life-cycle changes in the pattern of occupation, and (c) the secular growth income.

The following calculations take into account the secular growth income factor only. It might be thought that a trend increase in earnings across the board would not affect earnings differentials associated with different types of education and training. In fact, however, the presence of the age-factor means that a steady rise in all incomes over time by p per cent will influence the earnings differentials that could be observed between graduates of the Electronics Technology programs and those graduates who took the Radio and TV Repair courses.

To allow for this, Z should be rewritten as follows:

$$Z^* = \sum_{t=20}^{65} (x_t - y_t)\ (1+p)^{t-20} = \sum_{t=20}^{65} \frac{(S_t - C_t)\ (1+p)^{t-20}}{(1+i)^{t-20}}$$

$$Z^* = \sum_{t=20}^{65} (S_t - C_t) \quad \frac{1}{\left[\frac{(1+i)}{(1+p)}\right]^{t-20}}$$

Then if both i and p are small, $\left[\frac{(1+i)}{(1+p)}\right]$ approaches

1 + (i-p) and

$$Z^* = \sum_{t=20}^{65} (S_t - C_t) \quad \frac{1}{[1 + (i-p)]^{t-20}}$$

This means that the rates of return can be approximately adjusted for the secular trend by including the value of p. In other words, one would subtract the annual percentage income growth-rate from the calculated discount rates

It must be emphasized that these calculations do not imply that the decision to continue education beyond high school is made solely on investment grounds. The majority of students who leave school early probably devote their earnings to immediate consumption; they do not, in fact, have a certain sum of money which they can spend alternatively on their own education or on investment in physical assets.

The picture has slightly more relevance in the case of a whole family. If family income is low, then the income foregone when children continue full time study after they graduate from high school results, perhaps, more in a loss of current consumption satisfaction than in a loss of future investment income.

The fact remains that the structure of current earnings, and particularly the extra earnings that accrue to more educated and better trained individuals, do influence the decision to stay on for advanced training. The greater the shortage for a particular skill, the stronger the upward pressure on the earnings of that type of manpower, the higher the rates of return to vocational-technical training in that kind of professional preparation, and the more likely it is that the news of the "shortage" will filter down to the area vocational-technical schools. In this way, private rates of return are reflected in the differential supply of various kinds of manpower and, hence, must be taken into account in area and state manpower planning programs.

CHAPTER VI

A MODEL FOR FURTHER ANALYSIS

Before carrying out a cost-benefit study, it is necessary to define the means and criteria whereby the analysis will be made and conclusions drawn. First, all terms must be defined. Although "cost-effectiveness," "cost-benefit," and "cost-utility" are often used interchangeably, there seem to be three distinct levels for which the analysis is to be made.

We will define "effectiveness" as relating to fulfillment of short-range objectives and criteria which usually will be of a directly quantifiable nature (e.g., test scores, number of graduates, initial employment, drop-outs, etc.). This is the area which is of greatest interest to the educational administrator.

"Benefits" can be defined as a fulfillment of intermediate-range goals, where much of the data is still quantifiable, but qualitative data is also needed. This includes areas such as earnings five years after graduation and job stability. Internal benefits are stressed here. This area is of greatest interest to the educational planner and the economist.

Long-range objectives are fulfilled by "utility" criteria, which involve, primarily, external benefits, or returns to society. This area would include not only such quantitative factors as lifetime earnings and returns to society in the form of taxes, but also such qualitative factors as fulfillment of social demands, leisure activities, etc. through education. This is the realm in which formal education is, at best, indirectly involved, and where further study is required to quantify (if possible) the extent of its influence. This is the realm of greatest concern to the economist and social planner.

Figure 11 is a flowchart of a model for the analysis of alternative choices by utilizing cost-benefit, cost-effectiveness, and cost-utility concepts. It is important, first, to set the time period for planning. Three levels of objectives are set for the outputs of the educational system. These are determined by the needs of the greater societal system of which the school is a part. Figure 12 illustrates this interdependence between school and society.

Figure 11. -- MODEL FOR THE ANALYSIS

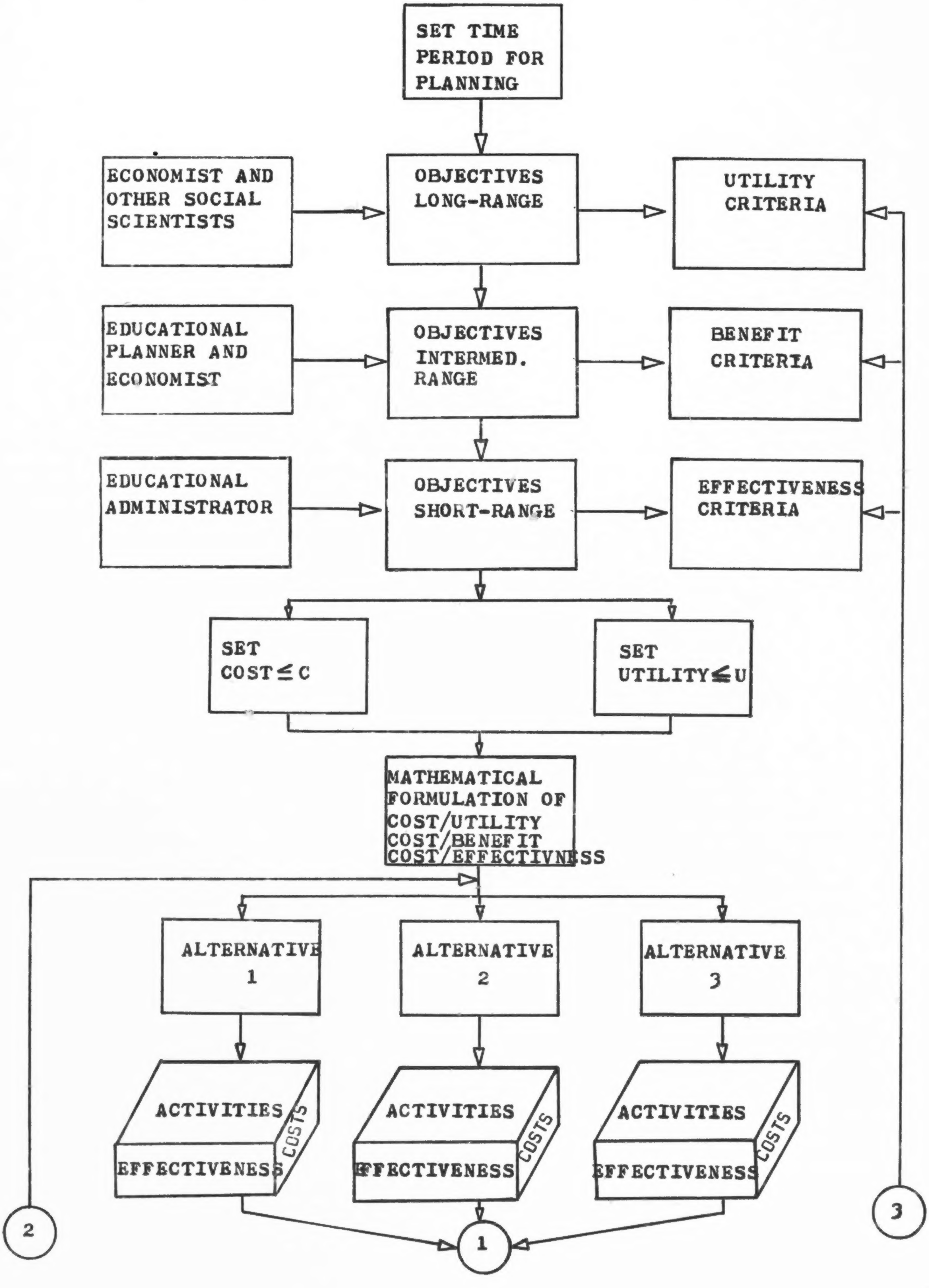

SET TIME PERIOD FOR PLANNING
ECONOMIST AND OTHER SOCIAL SCIENTISTS
OBJECTIVES LONG-RANGE
UTILITY CRITERIA
EDUCATIONAL PLANNER AND ECONOMIST
OBJECTIVES INTERMED. RANGE
BENEFIT CRITERIA
EDUCATIONAL ADMINISTRATOR
OBJECTIVES SHORT-RANGE
EFFECTIVENESS CRITERIA
SET COST ≤ C
SET UTILITY ≤ U
MATHEMATICAL FORMULATION OF COST/UTILITY COST/BENEFIT COST/EFFECTIVNESS
ALTERNATIVE 1
ALTERNATIVE 2
ALTERNATIVE 3
ACTIVITIES
COSTS
EFFECTIVENESS
ACTIVITIES
COSTS
EFFECTIVENESS
ACTIVITIES
COSTS
EFFECTIVENESS
2
1
3

Figure 11 (cont.)

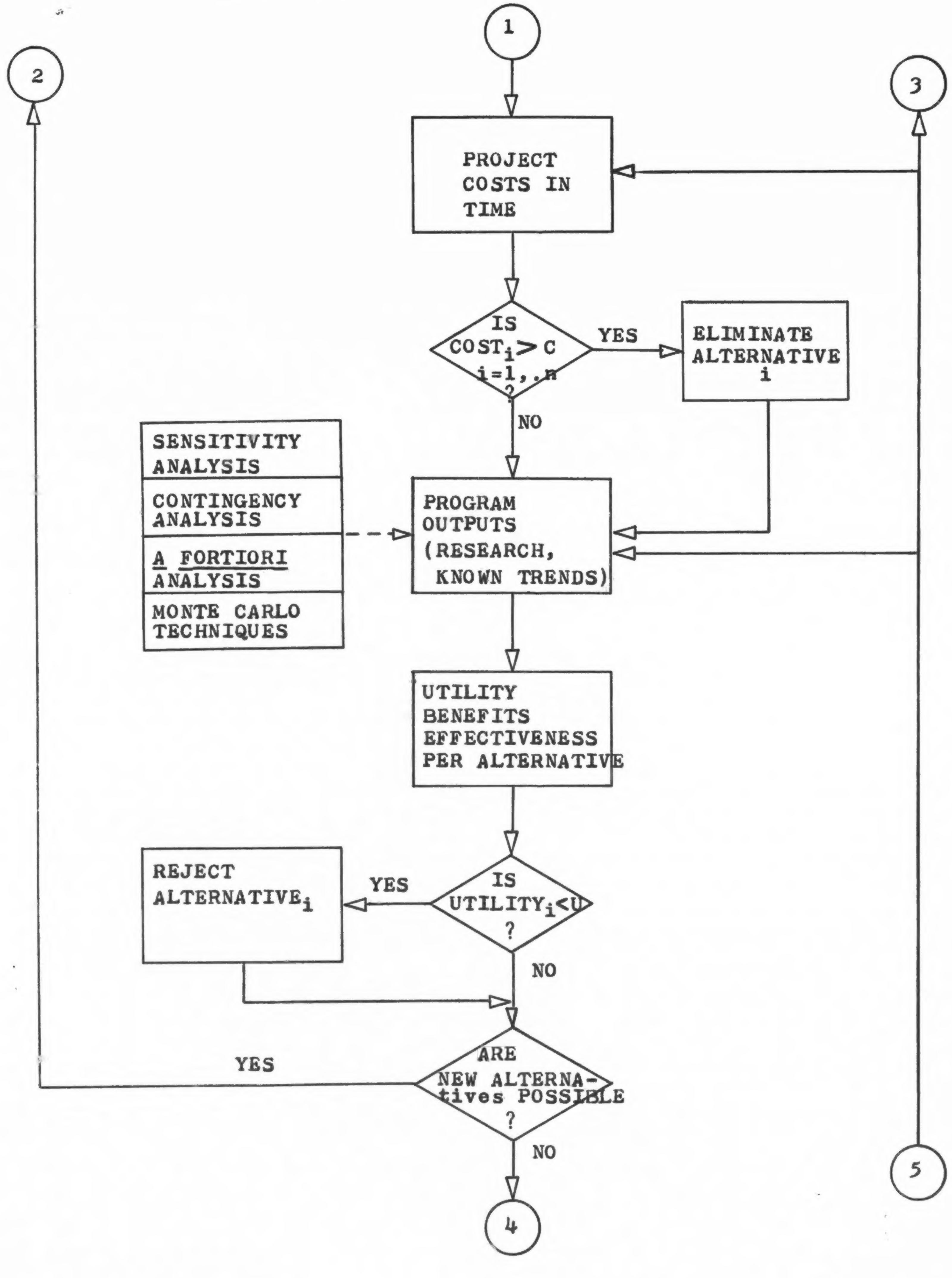
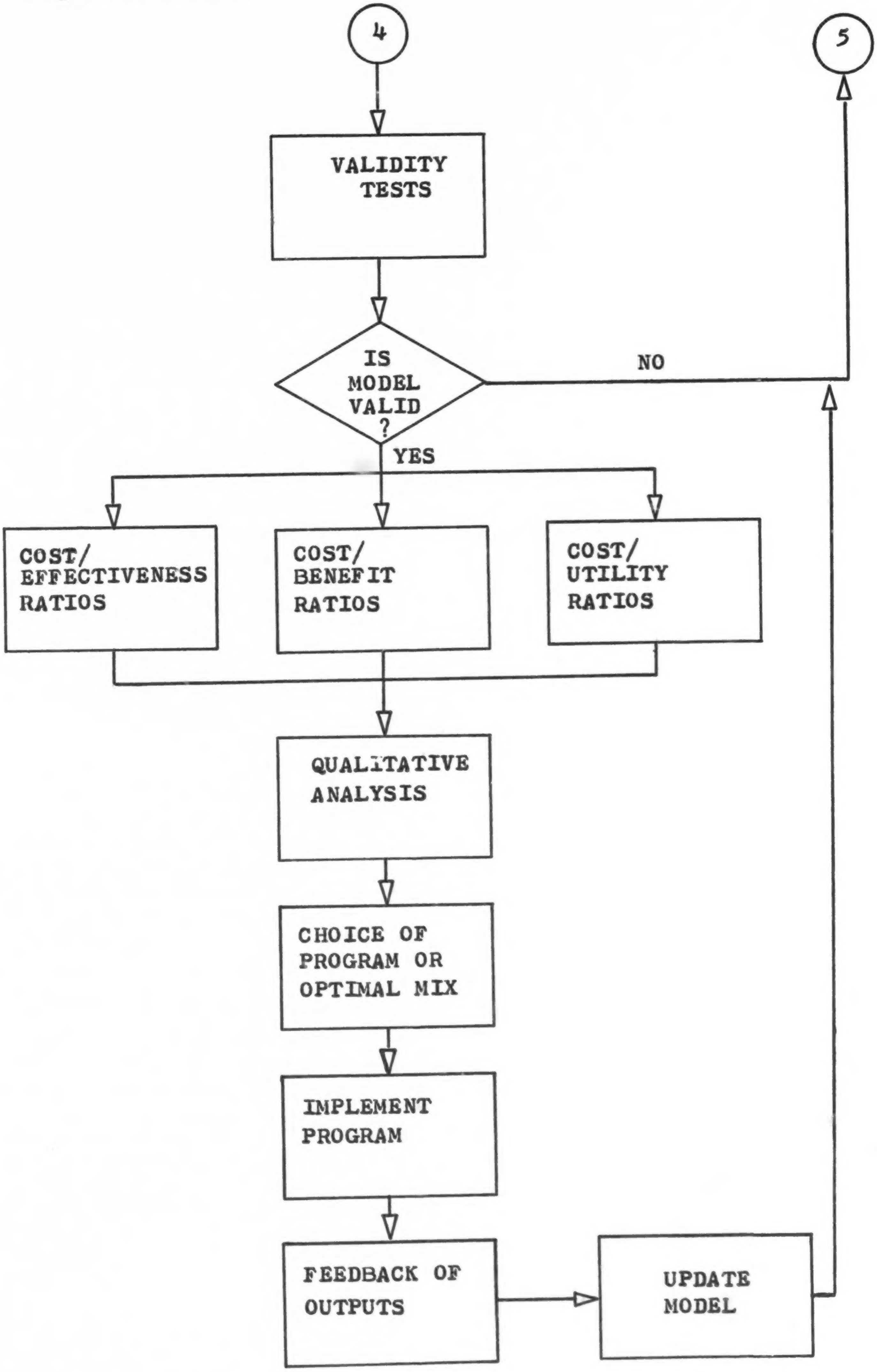

1
2
3
PROJECT COSTS IN TIME
IS COST$_i$ > C i=1,..n ?
YES
ELIMINATE ALTERNATIVE i
NO
SENSITIVITY ANALYSIS
CONTINGENCY ANALYSIS
A FORTIORI ANALYSIS
MONTE CARLO TECHNIQUES
PROGRAM OUTPUTS (RESEARCH, KNOWN TRENDS)
UTILITY BENEFITS EFFECTIVENESS PER ALTERNATIVE
REJECT ALTERNATIVE$_i$
YES
IS UTILITY$_i$<U ?
NO
YES
ARE NEW ALTERNA-tives POSSIBLE ?
NO
4
5

Figure 11 (cont.)


4
5
VALIDITY TESTS
IS MODEL VALID ?
NO
YES
COST/ EFFECTIVENESS RATIOS
COST/ BENEFIT RATIOS
COST/ UTILITY RATIOS
QUALITATIVE ANALYSIS
CHOICE OF PROGRAM OR OPTIMAL MIX
IMPLEMENT PROGRAM
FEEDBACK OF OUTPUTS
UPDATE MODEL

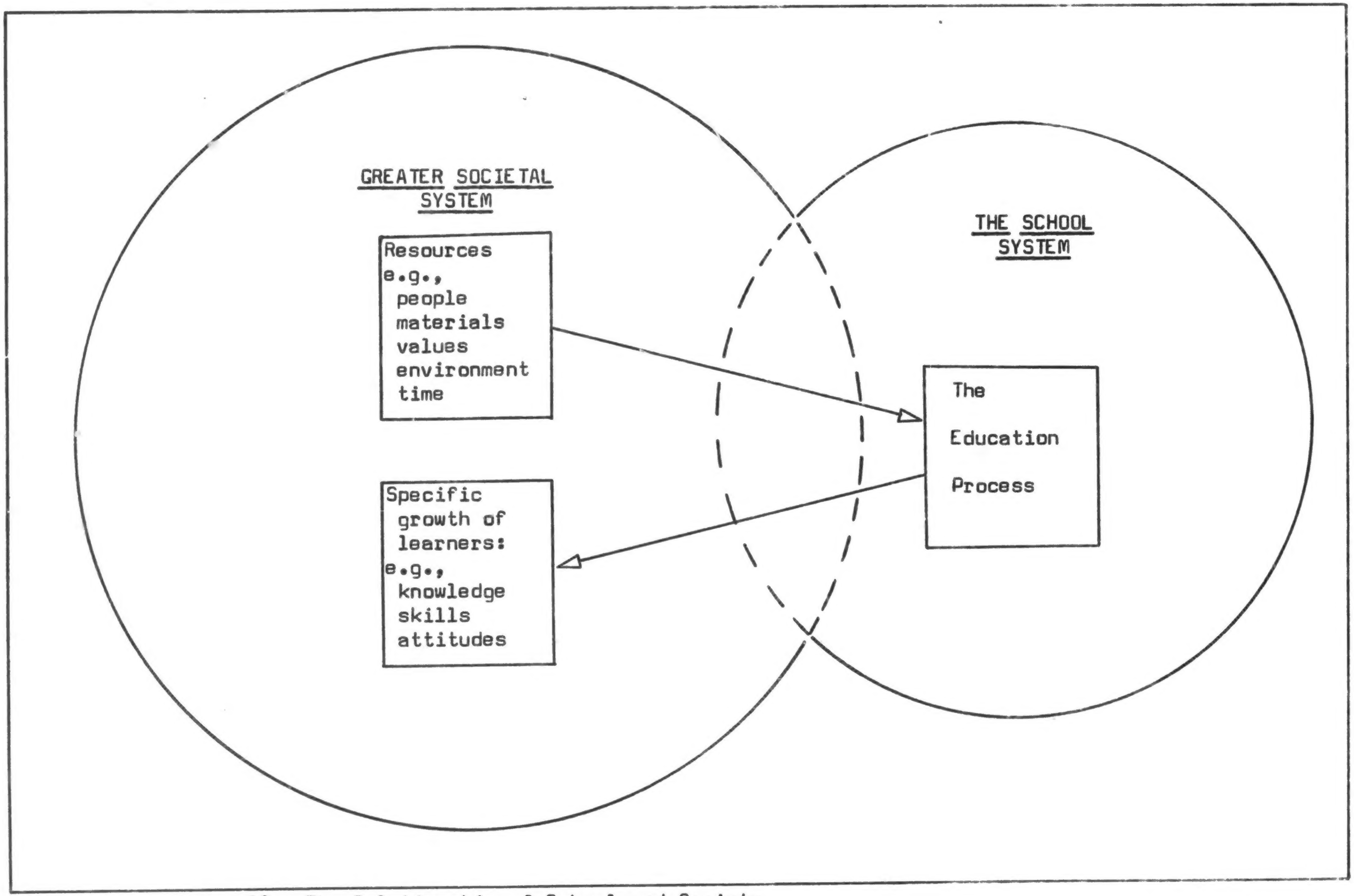

GREATER SOCIETAL SYSTEM
Resources
e.g.,
people
materials
values
environment
time
Specific
growth of
learners:
e.g.,
knowledge
skills
attitudes
THE SCHOOL SYSTEM
The
Education
Process

Figure 12.--The Relationship of School and Society
Research Corporation-Association of School Business Officials
Dade County Board of Public Instruction-Joint PPBES Project.
Presented at second PPBES Workshop in Miami, Fla, May 1969.

The process of identifying and selecting objectives is diagrammed in Figure 13. Objectives are determined at three levels: long-range, intermediate-range, and short-range. Criteria must be set, for achievement of objectives is measured by utility criteria, intermediate-range by benefit criteria, and short-range by effectiveness criteria. Criteria may be defined as standards on which a judgment or decision may be based. These would, ideally, measure utility, benefits, and effectiveness quantitatively, but may also be proximate. Criteria are formulated to determine successful achievement of the goals. They may be measured directly (through physical properties), indirectly (by sampling), and by survey (attitudes).

At the next level, limits are set on cost and utility (composite of utility, benefit, and effectiveness measures) factors. That is, maximum available cost and minimum acceptable utility are defined for any program which will be implemented. A mathematical formulation of cost-utility, cost-benefit, and cost-effectiveness functions is then made by incorporating the criteria generated by the three levels of objectives.

Following this, a feasible set of alternatives is generated, with corresponding costs. Each program is broken down into activities, their elements, and corresponding costs. In Figure 14, alternative programs are broken down in terms of learning and support activities, with personnel, materials, and other resources as the cost-elements.

Next it is necessary to project into the future. Cost is first to be projected, utilizing a dynamic approach, and taking an appropriate discount rate into account. The cost of each alternative must be checked against the maximum allowable cost, and those which exceed this limit are eliminated.

The outputs of each program must be estimated--from research and/or known trends. Figures 15 and 16 illustrate the relationship between antecedent conditions, process, and outcomes. Due to the uncertainty associated with time, however, various techniques can be applied to project these outputs. These include statistical techniques such as Monte Carlo, as well as sensitivity analysis, contingency analysis, and fortiori

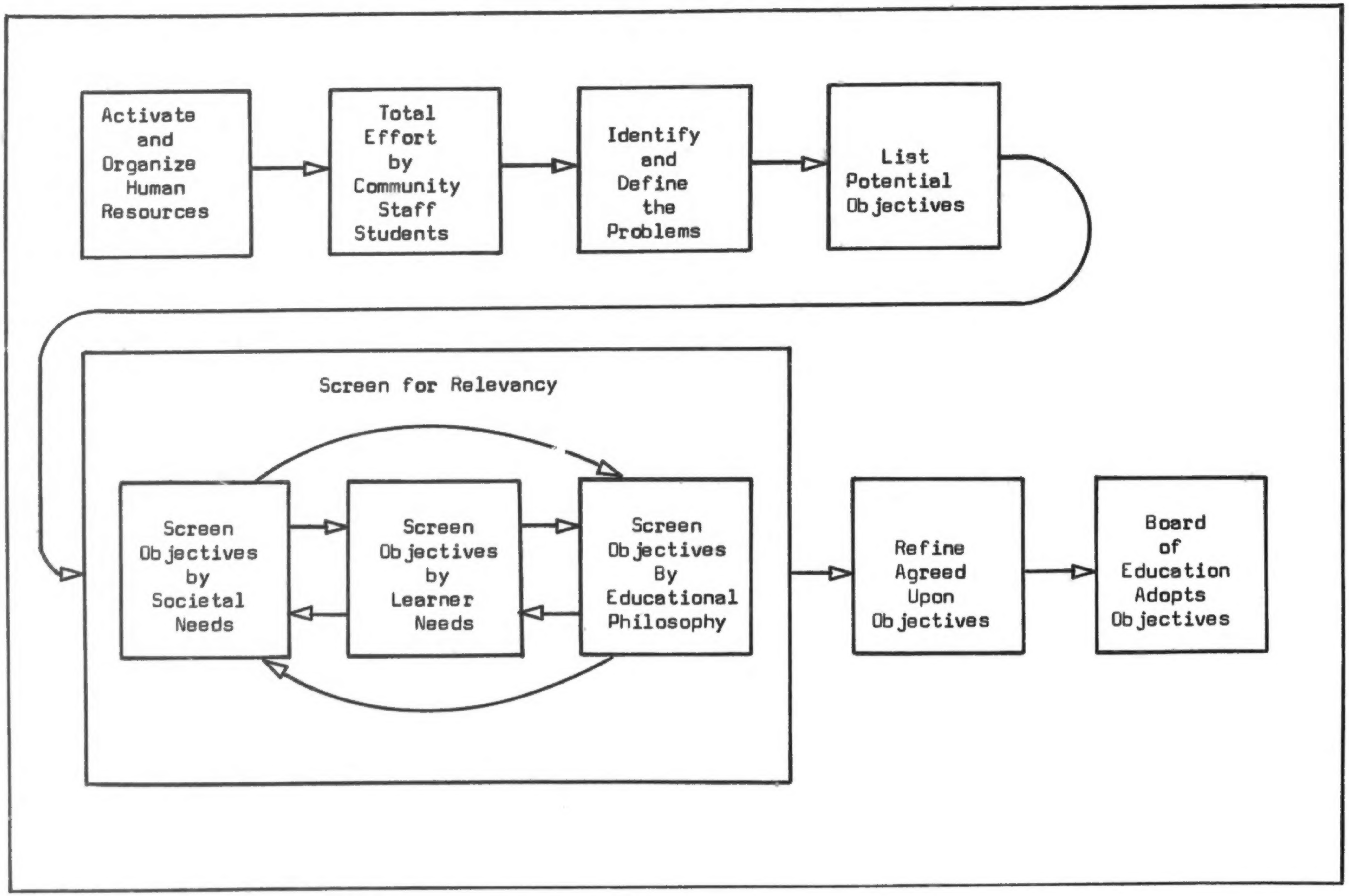
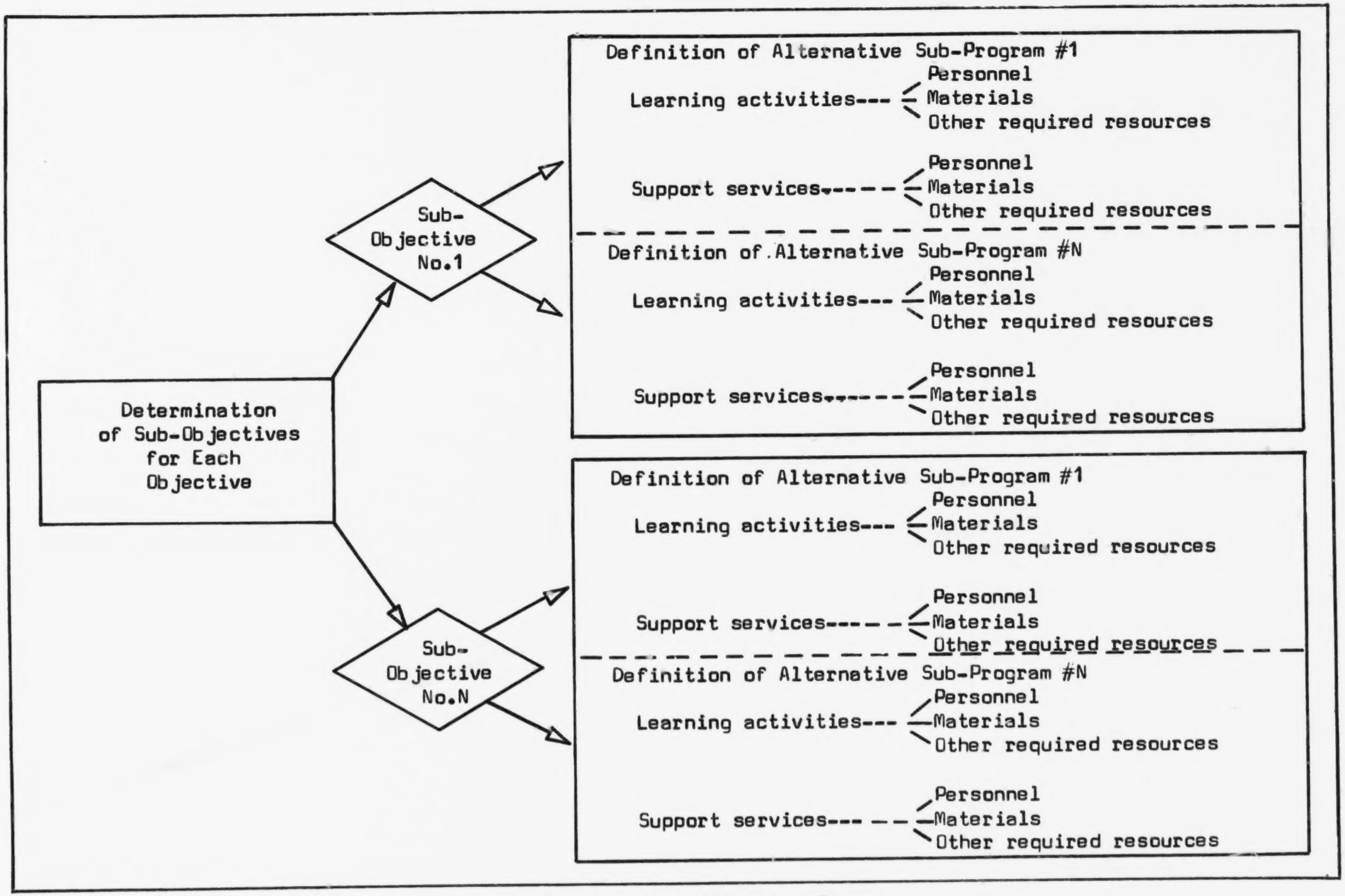

Activate and Organize Human Resources
Total Effort by Community Staff Students
Identify and Define the Problems
List Potential Objectives
Screen for Relevancy
Screen Objectives by Societal Needs
Screen Objectives by Learner Needs
Screen Objectives By Educational Philosophy
Refine Agreed Upon Objectives
Board of Education Adopts Objectives

Figure 13.- Identifying and Selecting Objectives

Research Corporation-Association of School Business Officials, op.cit.


Determination of Sub-Objectives for Each Objective
Sub-Objective No.1
Sub-Objective No.N
Definition of Alternative Sub-Program #1
Learning activities---
Personnel
Materials
Other required resources
Support services-----
Personnel
Materials
Other required resources
Definition of Alternative Sub-Program #N
Learning activities---
Personnel
Materials
Other required resources
Support services------
Personnel
Materials
Other required resources
Definition of Alternative Sub-Program #1
Learning activities---
Personnel
Materials
Other required resources
Support services-----
Personnel
Materials
Other required resources
Definition of Alternative Sub-Program #N
Learning activities---
Personnel
Materials
Other required resources
Support services--- --
Personnel
Materials
Other required resources

3

Figure 14.-Alternatives in the Program Identification Process

Research Corporation-Association of School Business Officials, op. cit.

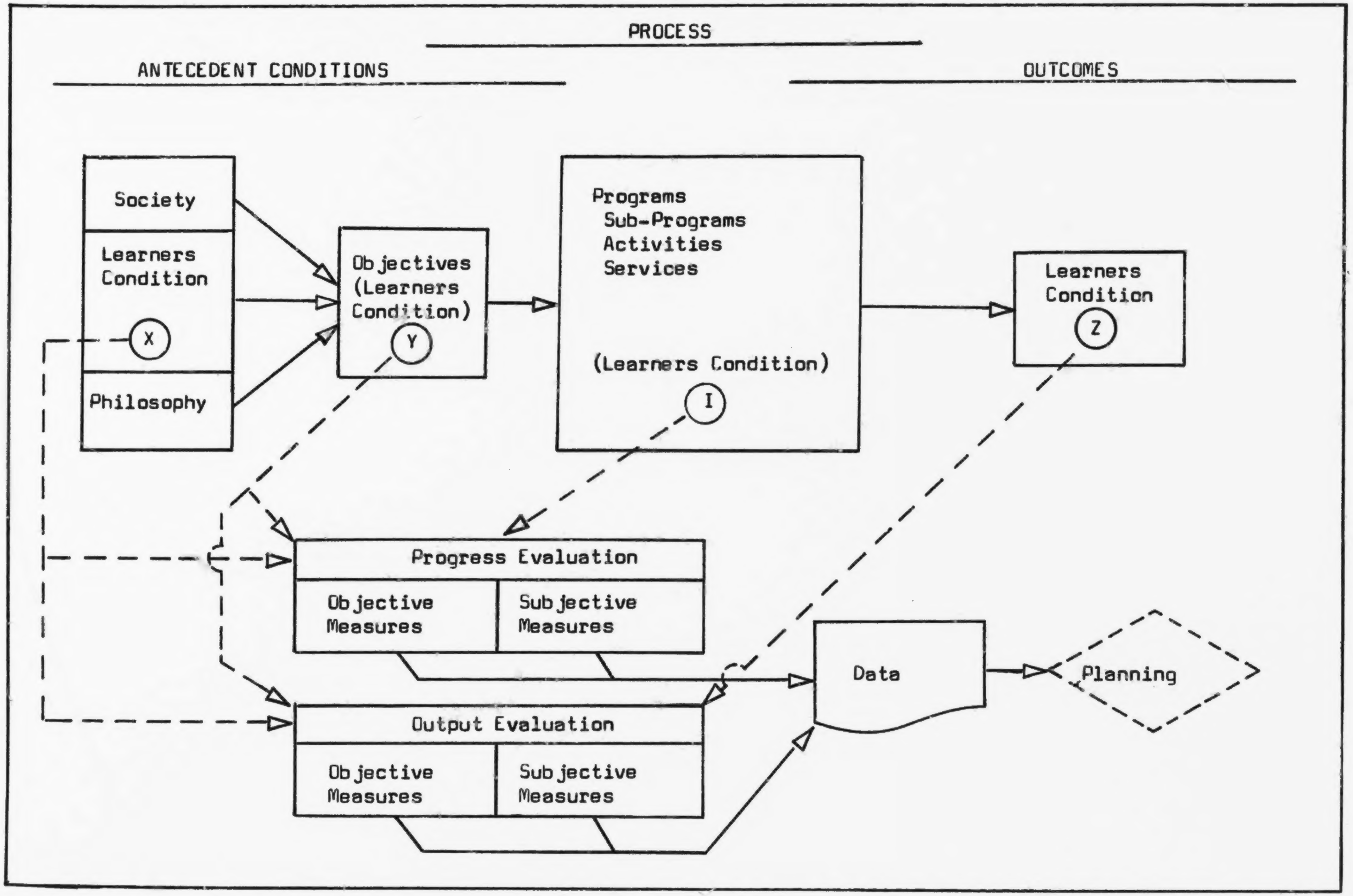

PROCESS
ANTECEDENT CONDITIONS
OUTCOMES
Society
Learners Condition
X
Philosophy
Objectives (Learners Condition)
Y
Programs
Sub-Programs
Activities
Services
(Learners Condition)
I
Learners Condition
Z
Progress Evaluation
Objective Measures
Subjective Measures
Output Evaluation
Objective Measures
Subjective Measures
Data
Planning

Figure 15.- Evaluation in Instructional Programs--An ERMD (PPBES) View

Research Corporation-Association of School Business Officials, op. cit.

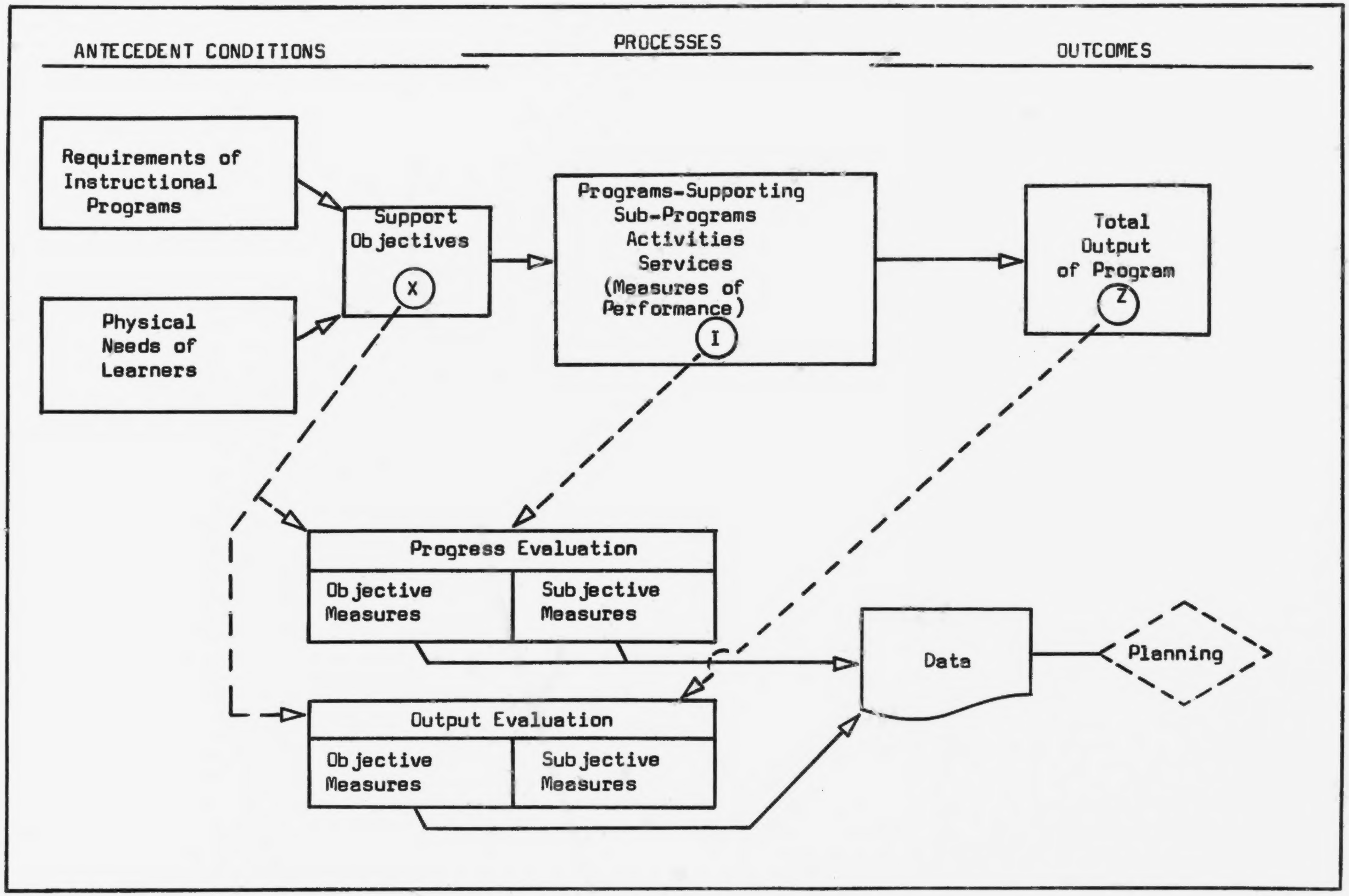

ANTECEDENT CONDITIONS
PROCESSES
OUTCOMES
Requirements of Instructional Programs
Physical Needs of Learners
Support Objectives
X
Programs-Supporting Sub-Programs Activities Services (Measures of Performance)
I
Total Output of Program
Z
Progress Evaluation
Objective Measures
Subjective Measures
Output Evaluation
Objective Measures
Subjective Measures
Data
Planning

Figure 16.- Evaluation in Non-Instructional Programs--An ERMD (PPBES) View

Research Corporation-Association of School Business Officials, op.cit.

analysis. From these results, through the application of the mathematical functions, estimates of utility, benefits, and effectiveness of each alternative can be made. If the composite of utility, benefit, and effectiveness of any alternative is less than the minimum acceptable level, that alternative is rejected.

In addition, any new alternatives which may have been formulated while studying these results must be analyzed. The process just described is used in analyzing these alternatives also.

At this point the validity of the model must be tested. According to Fisher, the following questions should be answered to determine the validity of the model.

A. Can the model describe known facts and situations reasonably well?

B. When the principal parameters involved are varied, do the results remain consistent and plausible?

C. Can it handle special cases where we already have some indication as to what the outcome should be?

D. Can it assign causes to known effects?[1]

The cost-effectiveness, cost-benefit, and cost-utility ratios can then be formed for each alternative. These results should be supplemented by a qualitative analysis of the situation. Qualitative considerations, according to Fisher, can take the following forms:

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[1] G. H. Fisher, "The World of Program Budgeting," A Paper presented at University of California, Los Angeles, June 2, 1966 (Santa Monica, California: The Rand Corporation), p. 19.

A. Qualitative analysis per se, as an integral part of the total analytical effort.

B. Interpretation of the quantitative work.

C. Discussion of relevant non-quantitative considerations that could not be taken into account in the "formal" analysis.[1]

The final choice of program or optimal mix of programs can then be determined. Implementation of the program is the next phase. Then, actual outputs of the system are fed back to the model and used to update it as necessary to insure optimal functioning.

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[1] *Ibid.*

CHAPTER VII

SUMMARY AND CONCLUSIONS

It is important to emphasize the value of pilot projects as such. After all, the estimated cost of public education activities for 1968-69 has been given as $43.3 Billion. This amount would probably more than double if costs of private educational institutions, and business, industrial, and military training programs were added. These amounts have multiple effects on the economy and raise a great number of questions which have a direct bearing on cost analyses.

The author has arrived at a number of conclusions--empirical, theoretical, and methodological--which are worthy of mention in their own right, and point to both new and further directions of study.

1. Data collection on a large scale is a very difficult task. The researchers found that:

    a. Available theoretical foundations for cost-benefit and cost-effectiveness within the larger framework of PPBS was much more limited than had been assumed.

    b. Data also was much scarcer and more incomplete than had been expected. It was necessary to develop new methods of extracting relevant student and economic data from a number of separate sources.

    c. As PPBS on school-district level becomes a reality, new "human capabilities" will be required. This may mean staff training and/or additional staff, including non-education types as economic analysts, statisticians, and others.

2. An interesting consequence of the investigation was the formulation of new conceptual tools and theoretical hypotheses, and the sharpening of old ones. Contact with the real situation in area vocational-technical schools has had an immediate payoff on the theoretical side; therefore, a major portion of this report is of a theoretical rather than directly empirical nature.

3. This pilot project has produced preliminary results which should be of great interest to educators. This bonus from the pilot research was not looked for, and is to be regarded as a by-product. For instance, the researchers have:

    a. learned a great deal about the problems of data collection with respect to educational and economic phenomena at the level of programs;

    b. examined and, to a certain extent, solved certain conceptual problems, such as constructing quantitative indices for cost-effectiveness and cost-utility measures;

    c. begun to throw new light on the efficiency of schools with regard to their employment and staffing policies.

    All of this is directly relevant to the programming, planning, and budgeting process.

4. The applicability of cost-effectiveness analysis in the evaluation of vocational-technical programs has been effectively argued. Since it functions at the marginal level it has considerable economic merit. As procedures for evaluating intangible benefits become more refined, the precision and efficiency of cost-effectiveness analysis will increase.

5. Income differentials among graduates of various vocational-technical programs have provided the base for strong arguments for diversified training and education. However, differentials must be utilized in view of the limitations inherent in their calculation.

6. Perhaps the most important result was the verification of the theory that cost-effectiveness procedures allow the forecasting of the costs of new programs over a period of years. Many mistakes have been made in the past because of a failure to take into account the cost, in future years, of programs that are attractive superficially, but that, eventually, prove to be bad educational investments.

7. Cost-effectiveness procedures could be valuable in comparing the benefits that may accrue from the more efficient utilization of vocational-technical school facilities by use of the facilities after hours for adult education or other programs, or through the lengthening of the present school year.

8. Another conclusion of direct positive relevance to PPBS is that cost-effectiveness analysis can become a tool in manpower planning. The author is a firm advocate of manpower planning and the rational adaption of our system of education and training to the needs of the economic system. It seems absurd to invest, annually, more than $40 billion in human capital without asking whether, from an economic standpoint, this money could not be allocated more efficiently. (Needless to say we do not want to be interpreted as asserting that the only criterion to be used is the investment or productivity criterion. But it is obvious that unless the economic impact of education is to be given no weight at all some form of manpower planning is both desirable and inevitable.)

9. It must be emphasized that vocational-technical area schools must begin keeping cost data and pertinent information which relates to productivity in education. The data should be kept at the school level. Only then can comparisons[1] between

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[1] "Comparisons" in this context consist of the comparison of marginal benefits with marginal costs (private and public) among the competing programs or courses.

alternative vocational-technical programs or courses become routine procedures.

10. The extent to which the author has refined program cost analysis makes it unfeasible to implement manual methods--especially the assignment of facility, furniture, and equipment depreciation costs--to a given program course. It should be noted that in the related literature these costs either have been avoided completely, or have been estimated (and sometimes rather roughly).

11. The preceding conclusion leads to another conclusion, namely, that it is essential to define and organize an information system in order to perform cost-benefit or cost-effectiveness analyses. It should prove extremely helpful to introduce and to rely on electronic data processing systems to perform cost studies.

12. If one could generalize from the education-earnings profiles of the 1965, 1966, 1967, and 1968 graduates of various vocational-technical programs offered by two area vocational-technical centers, one would be forced to conclude that:

    a. the private rate of return on "educational investment" is astonishingly high;

    b. all (public) cost-utility ratios (c/u) indicate a positive rate of return.

    But in view of the limitations of the data, such strong conclusions must be treated with extreme caution. It should be emphasized that all cost-utility ratios provided in this report are, at best, illustrative. A far larger and more representative sample would be required before anything more decisive could be said about the magnitude of the social or private rates of return on investment in vocational-technical education.

13. Having made his position as clear as possible, the author wishes to add the following. Concerning the interpretation of the training-earnings profiles which have been constructed, it can be said that they have two noteworthy implications for administrators and top-level decision-makers in vocational-technical education.

    a. Vocational-technical education in Florida *does have a positive rate of return* exceeding returns to capital in the rest of the economy.

    b. The return seems higher in the so-called "specialized programs" rather than in broad occupational programs. This suggests that the vocational-technical education system in Florida might be encouraged to adapt itself more to meeting *specific* demands at that point.

    While the margins of error are fairly large, as has been emphasized, it also would be advantageous to look more closely at *experimental* programs.

14. A related conclusion of direct positive relevance to vocational-technical education planning and to manpower planning in Florida is that it is worthwhile, with more attention being paid to the degree of flexibility of training requirements for particular occupations. Although the author has not been able to ascertain optimal training requirements, he has been able to establish:

    a. that the same occupation is staffed by people of varying educational backgrounds and experience;

    b. that it is not true that *one* particular training program stands out as obviously "right" for each occupation.

15. If monetary indices are accepted as a measure of effectiveness, then, given the excellent performance of graduates of Schools A and B in the labor market, extra public funds should be distributed toward vocational-technical education in order to maximize private and public benefits. In other words, if educational decision makers are really concerned with earnings, employment, and maximizing benefits, then the expansion of job-oriented training in vocational-technical area schools throughout Florida should be given high priority.

APPENDIX A

COST-EFFECTIVENESS ANALYSIS OF MANPOWER PROGRAM

COST-EFFECTIVENESS ANALYSIS OF MANPOWER PROGRAMS

This section of the report is intended to serve as a guideline for an appraisal of cost-effectiveness studies of training and retraining programs under the Manpower Development and Training Act.[1]

> Cost-effectiveness analysis of manpower programs in the Manpower Administration of the U. S. Department of Labor was initiated in 1966. Because of limited finances and staff resources, and the newness of the methodological problems, only a very modest program has been attempted. Much of the work has been and is being performed jointly by Manpower Administration and contractor staff; some studies are completely in-house; and still others have been contracted out to private researchers under the Manpower Administration's program of research grants and contracts.
>
> The main output of the first year and a half of activity was a manual outlining the analytical problems of cost-effectiveness analysis within the manpower context, and the preparation of three pilot projects--in each of the Manpower Administration's three major program categories and utilizing each of three types of analytic techniques. The programs and techniques are paired as follows:

	Analytic technique	Program category
1.	Cost-effectiveness analysis of alternative programs	Manpower development assistance (primarily training programs)
2.	Cost-goal analysis	Employment assistance (primarily the activities of the Federal-State Employment Service system)
3.	Cost-constraint analysis	Income maintenance (primarily unemployment insurance)

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[1] This material has been adopted from: Manpower Report of the President, including A Report on Manpower Requirements, Resources, Utilization, and Training (Washington, D. C.: U.S. Department of Labor, 1969).

PILOT STUDIES

The first of the pilot studies is a comparison of the costs and benefits of institutional and on-the-job training under the Manpower Development and Training Act. Despite many qualifications, resulting mainly from data deficiencies, the study indicates the value of both on-the-job and institutional training as Federal investments. The average net Federal benefit-cost ratio, defined as the direct and indirect benefits to society (exclusive of increased taxes paid) compared to the Federal investment per trainee, is found to be 3.28 to 1 for on-the-job training and 1.78 to 1 for institutional training, only one year after training. Even without prejudging the number of years for which the differential benefit would last, or whether it would tend to increase, decrease, or remain constant, or without arbitrarily assigning a discount rate by which to calculate present values of benefits, the desirability of both programs is clear. The corresponding benefit-cost ratios computed only for those trainees who completed all units of instruction are somewhat lower, since the total costs are spread over a smaller number of trainees. But even here, the ratios are 2.13 to 1 for on-the-job training and 1.09 to 1 for institutional training.

On the cost side, total institutional training and allowance costs per trainee (or completer) are a little less than half the total costs per on-the-job trainee (or completer). (This comparison involves some rather strong assumptions concerning the private employer costs of on-the-job training, for which there was little statistical confirmation.) The reverse is true for Federal costs, however; the cost to Government for each on-the-job trainee is roughly one-half the cost for each person receiving institutional training.

On the benefit side--and it must be emphasized that this study deals with increments to earnings, not the absolute level of earnings--the institutional trainee does a little better than the on-the-job trainee. This is due to a larger posttraining increase in the duration of employment for the institutional trainee, which more than compensates for the 30 to 50 percent greater increase in hourly wage accruing to the on-the-job trainee.[1] Institutional trainees in the sample used for the pilot study typically had longer periods of unemployment prior to their training than did on-the-job trainees. Since they started out with more to gain in terms of length of employment, the training reduced their posttraining periods of unemployment more than it reduced the unemployment of on-the-job trainees. Still, in the year after training, on-the-job trainees had less unemployment than did institutional trainees.

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[1] When duration of employment during the first posttraining year was compared with that of the year preceding training, institutional trainees were found to have averaged a 5-week longer increase than OJT trainees.

The second pilot study, dealing with an illustrative cost-goal analysis in the U. S. Employment Service area, was designed primarily to indicate a specific kind of measurement of costs and benefits; namely, the estimated benefits to the gross national product that would result from an additional dollar of expenditure on Employment Service activities--additional, that is, to the amounts expended in fiscal year 1965. It also demonstrates a method of measuring the differences in the estimated benefit to GNP that would result from placing that additional dollar into one or another of the battery of services provided by the Federal-State Employment Service system. For example, an increase in openings per new job applicant greatly influenced earnings of placed applicants per new application, suggesting that additional investment in job development and job solicitation would have a high payoff in comparison with comparable investment in other Employment Service activities. (It should be noted that the study findings were based on the economic situation in fiscal 1965. The payoff on job solicitation would be influenced by market demand; what that payoff would be under different economic conditions was not investigated in this study.)

The main conclusion of the study is that the GNP would receive a payoff of $14 a year for each additional dollar of resources invested in U. S. Employment Service nonfarm activities. This finding, which is also subject to severe statistical limitations because of inadequate data resources, is valid only for years in which similar economic, job market, budgetary, and operating conditions prevail, and would require modification to account for significant differences in any of these factors.

In this study, Employment Service benefits were expressed in terms of one, and only one, criterion: estimated earnings of placed applicants (nonagricultural), excluding short-time and repeat placements, per new application. This gross measure clearly understates full benefits provided by the Employment Service since it excludes:

1. Services which did not culminate in placements, but

which may have yielded to the recipients dollar benefits that could be measured as additions to GNP--for example, job market information; counseling and aptitude testing; identification of need; and referral to training, rehabilitation, or other social service agencies. (Such services, designed primarily to increase employability rather than to make placements, have an increasing role in the activities of the Employment Service, with its present emphasis on the poor and disadvantaged.)

2. Nondollar (and perhaps nonquantifiable) benefits, such as better job attitudes, greater job satisfaction, and greater job stability.

On the other hand, the measure probably overstates the dollar benefits to applicants placed by the Employment Service, since their actual annual earnings are probably less than the average annual earnings, by occupation, estimated for each State by the Bureau of the Census and used as the estimated earnings of applicants in the year following placement. Certainly many of the Employment Service placements are made at entry-level, rather than average, wages.

The third illustrative study was an attempt to assess the "costs," as related to the anticyclical objectives of unemployment insurance, of failure to enact the proposed 1966 amendments to the unemployment insurance legislation. These amendments would have extended the duration of benefits, increased coverage, and provided larger benefits relative to weekly earnings. Available data indicate that the individuals who would have been affected by the amendments would have longer durations of unemployment, fewer assets, and higher current indebtedness than current unemployment insurance recipients--all factors which strongly affect their marginal propensities to consume.

This analysis is concerned primarily with the relative anticyclical impact of the defeated amendments, and not with the absolute level of anticyclical effects to be expected from the entire unemployment insurance program. While the program operates quite effectively as an automatic stabilizer in a period of economic decline, the absolute amounts involved are relatively small, and the program is not likely to become a major tool of anticyclical policy.

STAFF STUDIES

In addition to these three studies, there are two significant staff undertakings. The more important is a theoretical model, to indicate the effect of an incremental year of education or training on employment and lifetime earnings, by race, sex, and major occupational group. It also provides a method (though not enough hard data) for estimating such items as, for example, the cost of raising a nonwhite male, age 25, from unskilled to skilled status, or the combined costs to a Negro or to a woman, of job discrimination and differences in educational standards. The study is a contribution to the theory of human capital which, it is believed, improves on earlier pioneering work in five major ways:

1. By emphasizing the intergenerational basis for the investment in human capital.

2. By providing a method for estimating the dollar value of the contribution of a nonworking mother's care to the education and the training of her child, and the real cost to society of providing paid services to replace that contribution if she enters the job market while her children are still young.

3. By estimating the relative importance for resource allocation of the four components of education and training--parental care, formal education, training on the job, and other experience.

4. By measuring the effect of family size on the dollar value of the education and training of the individual.

5. By systematically establishing differential discount rates to be applied in estimating the present dollar value of education and training for different occupational groups, by sex and color.

APPENDIX B

INVESTMENT CRITERIA[1] IN EDUCATION

INVESTMENT CRITERIA[1] IN EDUCATION

There is a variety of investment criteria which is available to the education decision maker. At the simplest level of analysis *benefit differentials* and *differential costs* can be estimated. *Pay-back periods* can also be estimated. The *net expected present value*, the *cost-benefit ratio*, the *ratio of differences in marginal costs*, the *expected annual net benefits*, and the *expected internal rates of return* can be calculated. Under certain conditions, these last four measures are equivalent and provide the same guidance to investment decision making. The exceptions are noted below and comprise the bulk of this discussion.

The Correct Criterion

In general, the most correct criterion for making choices among competing investment alternatives in the criterion of maximizing the difference between the present value of benefits and the present value of costs. However, there are both practical and theoretical conditions which either commonly exist or can be devised which demonstrate that no single investment decision criterion is theoretically correct for all investment situations.[2] This discussion concentrates on only three of the above criteria: the expected internal rate of return; the expected net present value; and the cost-benefit ratio. The other measures are dealt with in only cursory fashion.

Cost and Benefit Differentials

Cost and benefit differentials represent a necessary but incomplete stage of economic analysis. These differentials are useful to show the configuration of the data and to provide the inputs to the proper (for a given set of constraints) investment criterion. However, alone, they are not a useful guide to decision making. Yet, one commonly perceives misunderstanding of this fact. For instance, a given project A, costing X dollars more than an alternative project B, is averred (by its advocates) to be of "higher quality" or (by its detractors) to be "too costly." But higher quality or too costly in what sense? Both these statements, taken by themselves, are nonsense in terms of economic efficiency. Costs and benefits must always be related to each other. More specifically, marginal costs must be related to marginal benefits. If the marginal or extra costs of two alternative programs are the same, but one has higher benefits than the other, it is possible to assert, other things equal, that the project with the larger extra benefits is, in an economic efficiency sense, better than that with the smaller. But how much better and whether only one or both programs are efficient investments cannot be determined without further analysis. And the confusion becomes even greater when one must make a choice between investing in a high cost-high return program and a low cost-low return program.

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[1] Most of this material has been adopted from J. J. Kaufman, *et al*., Institute for Research on Human Resources, *An Analysis of the Comparative Costs and Benefits of Vocational Versus Academic Education in Secondary Schools* (State College: Pennsylvania State University, October, 1967), pp. 39-40.

[2] See, especially Jack Hirshleifer, "On the Theory of Optimal Investment Decision," *Journal of Political Economy* (August 1958), pp. 329-52, and Martin J. Bailey, "Formal Criteria for Investment Decisions," Journal of Political Economy (October, 1959), pp. 476-88.

For instance, which is the better educational investment: project A which has an initial cost outlay of $200 and yields an annual benefit of $50 or project B which has an initial cost outlay of $1200 and an average yearly benefit of $200? The first may be better than the second; the second better than the first; or, both may be equally good or equally inefficient.

The Pay-back Period

The pay-back period is a simple ratio of total costs, C, to marginal benefits, b, with benefits measured over a given time unit such as a month or year. Thus, C/b equals the pay-back period.[1] This simple index relates costs and benefits to each other and different programs can be crudely judged as to their relative effectiveness. The criterion is to select that investment with the shortest pay-back period. For example, using the illustrative data of project A above yields a pay-back period of four years ($200/$50). Under the same set of assumptions, the pay-back period for B is six years. Thus, by this criterion one should select project A over B, other things equal.

The pay-back criterion, however, suffers from a variety of conceptual flaws. First, it ignores the fact that costs and benefits of competing investment alternatives are distributed through time and have different time profiles. Discounting is necessary to make the different cost-benefit profiles commensurable. Second, the absolute net benefits between alternatives may differ but the use of the ratio will obscure this. Third, as with the expected internal rate of return, the pay-back criterion breaks down completely in those cases where investment alternatives are mutually exclusive.

A Consideration of Three Criteria

The expected net present value criterion and its variant, expected annual net present value, the cost-benefit ratio, and the expected internal rate of return, will often provide the same results in terms of the proper ranking of alternative investments. However, the expected internal rate of return rule is not always conceptually equivalent to the total net expected capital value and annual net capital benefits rules. These three rules are conceptually equivalent only under some fairly severe assumptions. These assumptions are:

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[1] Under certain conditions the reciprocal of the pay-back period is equal to the expected internal rate of return. For this to occur, all costs must occur in the initial time period, and benefits must be constant and continue infinitely. See Myron J. Gordon, "The Payoff Period and the Rate of Profit," in The Management of Corporate Capital, ed. by E. Solomon (New York: The Free Press, 1959), pp. 48-55.

> if and only if (a) capital markets are perfectly competitive; (b) all available projects are completely divisible; (c) there is no interdependency among projects; and, (d) all net returns can be reinvested at their own internal rates of return up to the terminal date of the longest-lived project.[1]

The appropriateness of these three criteria is analyzed below in terms of their possible deviations from these conditions.

Expected Net Present Value

The expected net present value criterion can be stated as follows:

> Given the appropriate discount rate, one should adopt any project for which the present value of the discounted stream of net benefits is greater than zero. Or, if more than one project has net discounted benefits greater than zero at the given rate of discount, adopt that project with the highest present value of net benefits. If funds still exist to invest, adopt the project with the next highest present value, and so on, until funds are exhausted or projects with positive or zero net present values are exhausted.

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[1] M. Blaug, "An Economic Interpretation of the Private Demands for Education," *Economics* (May, 1966), p. 168.

Computationally,[1] an equation for achieving this measure is as follows:

$$(7)\quad V_o = \frac{s_0}{(1+i)^0} + \frac{s_1}{(1+i)^1} + \frac{s_2}{(1+i)^2} + \ldots + \frac{s_t}{(1+i)^n}.$$

Where:

V_o is total net present value, i is the rate of interest used to discount; n is the last year in which returns from the investment occur; s_t is the sum of benefits, b_t, less costs, c_t, in any given time period, t.

This formula accounts for the fact that costs may occur in other than the very beginning of the period. If conditions affecting the value of the discount rate are expected to change over the benefit period, different values for the discount rate can be inserted at such points.

Using the illustrative data for project A above and given the following assumptions: $i = 6$ per cent, n and $t = 20$; $b_t = \$50$; $c_t = \$200$; and the cost outlay occurs at the very inception of the investment period--the present value of benefits for project A is:

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[1] Most of the following formulas are based on Hirshleifer, Dehaven and Milliman, op. cit., chapters 6 and 7.

$$(7a) \quad V_o = \frac{\$0 - \$200}{(1 + .06)^0} + \frac{\$50 - 0}{(1 + .06)^1} + \frac{\$50 - 0}{(1 + .06)^2} + \ldots + \frac{\$50 - 0}{(1 + .06)^{20}}.$$

$$(7b) \quad V_o = \frac{-\$200}{1} + \frac{\$50}{1.060} + \frac{\$50}{1.124} + \ldots + \frac{\$50}{3.207}.$$

$$(7c) \quad V_o = -\$200 + \$47.17 + \$44.48 + \ldots + \$15.59 = \$374.$$

And, V_o for project B is \$1092, where the assumptions are the same as above except that $b_t = \$200$ and $c_t = \$1200$.

Therefore, if six per cent is the proper social opportunity cost of investment funds, then in pure economic efficiency terms, assuming monetary benefits are a proper index of social benefits, project B should be preferred over project A.

If the benefit stream is constant from its inception and continues to infinity, the total present value of benefits can simply be denoted as:

$$(8) \quad V_o = \frac{s}{i}.$$

Where:

i as the chosen rate of interest used to discount and s is the level of net annual benefit. Here, benefits must begin at time 1 and all costs, C_o, must be incurred at time zero, the immediate inception of the project. Then, $V_o - C_o$ must be zero or greater in order to invest in the given project. Thus, the net present value of benefits for project A is \$833 - \$200, or \$633, while for project B it is \$3333 - \$1200, or \$2133. The use of higher interest rates in discounting will substantially reduce the disparity between the results of equation (7) and those of equation (8). Thus, at just a 10 per cent rate of discount V_o becomes \$500 for project A and \$2000 for project B, with $V_o - C_o$ being \$300 and \$800, respectively. Clearly, the rate of interest by which to discount becomes crucial in cost-benefit analysis.

If the net benefit stream is constant but finite, beginning at time 1 and ending at time n, the discounting formula is:

$$(9) \quad V_o = s \frac{(1 + i)^n - 1}{i(1 + i)^n}.$$

Where the symbols are interpreted the same as in equation (7) above.

Thus, for project A,

$$(9a) \quad V_o = 50 \frac{(1 + .06)^{20} - 1}{.06(1 + .06)^{20}}.$$

$$(9b) \quad V_o = 50 \frac{3.207 - 1}{.06(3.207)}.$$

$$(9c) \quad V_o = 50 \frac{2.207}{.1924} = 574.$$

And, net benefits are \$475-\$200, or \$374.

Expected Annual Net Present Benefit

This rule yields investment decision results identical to the expected net present value criterion. The rule is:

> based upon the principle of finding the level net stream that corresponds to the actual stream of costs and benefits associated with the project.[1]

The formula is as follows:

$$(10) \quad s = \frac{V_o \, i \, (1+i)^n}{(1+i)^n - 1}$$

where $V_o = s \dfrac{(1+i)^n - 1}{i(1+i)^n}$ and

the rest of the symbols are interpreted as in equation (7) above.

In terms of investment decision making this rule states that, at the chosen rate of interest, one should:

> select all projects where the constant annuity with the same present value as benefits exceeds the constant annuity (of the same duration) with the same present value as costs.[2]

For both this rule and the expected net present benefits rule, costs, c, and benefits, b, can be estimated separately, simply by substituting either of these two values in equations (7) and (10) where s occurs. Also, V_o in equation (10) becomes C_o or B_o, respectively.

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[1] *Ibid*., p. 155.

[2] Prest and Turvey, *op. cit.*, p. 703.

Next, the discounted total costs or cost annuity, C_o or c, respectively, is subtracted from the discounted total benefits or benefit annuity, B_o or b, respectively. Then, for an investment to occur, the difference, $B_o - C_o$ or b - c, must be zero or greater. One useful aspect of the expected annual net present benefit rule is that, if only costs (or benefits) are know, annual discounted costs (or benefits) can be estimated. A judgment can then be made as to the likelihood that expected annual net present benefits (or costs) will be as great or greater than their costs (benefits) counterparts.

Using the hypothetical data for project A one has:

$$\text{(10a)} \quad c = \frac{C_o i\ (1+i)^n}{(1+i)^n - 1}.$$

$$\text{(10b)} \quad c = \frac{\$200\ (.06)\ (1.06)^{20}}{(1.06)^{20} - 1}$$

$$= \$17.42\text{; and,}$$

$$\text{(10c)} \quad b = \frac{B_o i\ (1+i)^n}{(1+i)^n - 1}.$$

$$\text{(10d)} \quad b = \frac{\$574\ (.06)\ (1.06)^{20}}{(1.06)^{20} - 1} = \$50.00.$$

The respective figures for project B are c = \$104.52 and b = \$199.63. Thus, in each case, b is greater than c at the chosen interest rate and, in pure economic efficiency terms, assuming monetary benefits are an appropriate index of social benefits, it pays to invest in either project, but project B is more desirable than project A.

The Benefit-Cost Ratio

The benefit-cost ratio tells the decision maker to invest in those projects for which the ratio of the present value of benefits to the present value of costs is greater than unity. The equation for this rule is as follows:[1]

$$(11)\quad \frac{\dfrac{b_0}{(1+i)^0} + \dfrac{b_1}{(1+i)^1} + \dfrac{b_2}{(1+i)^2} + \ldots + \dfrac{b_t}{(1+i)^n}}{\dfrac{c_0}{(1+i)^0} + \dfrac{c_1}{(1+i)^1} + \dfrac{c_2}{(1+i)^2} + \ldots + \dfrac{c_t}{(1+i)^n}} > 1.$$

The symbols are interpreted in the same manner as in equation (7) above.

In benefit-cost ratio terms, the data for project A above give the following results:

$$(11a)\quad \frac{\dfrac{\$0}{(1+.06)^0} + \dfrac{\$50}{(1.06)^1} + \dfrac{\$50}{(1+.06)^2} + \ldots + \dfrac{\$50}{(1+.06)^{20}}}{\dfrac{\$200}{(1+.06)^0} + \dfrac{0}{(1+.06)^1} + \dfrac{0}{(1+.07)^2} + \ldots + \dfrac{0}{(1+.06)^{20}}} =$$

$$\frac{\$574}{\$200} = 2.87$$

The ratio for project B is \$2292/\$1200 or 1.91. By this criterion, project A is preferred over project B as long as the two projects are not mutually exclusive.

The Ratio of Difference in Marginal Benefits to Difference in Marginal Costs.--A variation on the benefit-cost ratio is the ratio of the difference in marginal benefits to the difference in marginal costs between two alternative projects. Equation (12) expresses this ratio algebraically as follows:

$$(12) \qquad \frac{\dfrac{b_{X_0} - b_{Y_0}}{(1+i)^0} + \dfrac{b_{X_1} - b_{Y_1}}{(1+i)^1} + \dfrac{b_{X_2} - b_{Y_2}}{(1+i)^2} + \dots + \dfrac{b_{X_t} - b_{Y_t}}{(1+i)^n}}{\dfrac{c_{X_0} - c_{Y_0}}{(1+i)^0} + \dfrac{c_{X_1} - c_{Y_1}}{(1+i)^1} + \dfrac{c_{X_2} - c_{Y_2}}{(1+i)^2} + \dots + \dfrac{c_{X_t} - c_{Y_t}}{(1+i)^n}}$$

where, as above b and c refer to marginal benefits and costs, i is the rate of interest used in discounting, t and n are the number of time periods, and the subscripts X and Y refer to projects X and Y, respectively.

Briefly stated, this rule says that as long as the ratio of discounted benefit differences to discounted cost differences is greater than zero, then additional public funds should be invested in project X in preference to project Y.

To be more specific, the following cases indicate the direction in which an extra dollar of public funds for educational expenditure should be spent.

A. When $\dfrac{\Sigma(b_X - b_Y)}{\Sigma(c_X - c_Y)} > 0,$

1) if $b_X > b_Y$ and $c_X > c_Y$, then additional dollars of public funds should be devoted to project X; and,

2) if $b_X < b_Y$ and $c_X < c_Y$, then additional dollars of public funds should be devoted to project Y.

B. When $\frac{\Sigma(b_X - b_Y)}{\Sigma(c_X - c_Y)} > 0$,

1) if $b_X > b_Y$ and $c_X < c_Y$, then additional dollars of public funds should be devoted to project X; and,

2) if $b_X < b_Y$ and $c_X > c_Y$, then additional dollars of public funds should be devoted to project Y.

C. When $\frac{\Sigma(b_X - b_Y)}{\Sigma(c_X - c_Y)} = 0$

only if $b_X = b_Y$ and $c_X \gtrless c_Y$, then if $C_X > C_Y$, additional dollars of public funds should be devoted to project Y. If $c_X < c_Y$, additional dollars should be devoted to project X. This is so because if this ratio is greater than zero, then the ratio of benefits to costs for project X is greater than the ratio of benefits to costs for project Y.

An additional problem with this variation in the benefit-cost ratio criterion should be noted. Even though it is rational to invest extra public funds in project X as long as the ratio expressed by equation (12) is greater than zero, this does not imply that the marginal internal rate of return to project X is equal to or greater than the social opportunity cost of capital. Indeed, the marginal internal rate of return to project X could be less than the social opportunity cost of capital. Project X may even be suffering net losses. Even so, project Y will be suffering even greater losses, so that a shift of expenditure from project Y to project X (or, the expenditure of an additional dollar on project X instead of project Y), will still result in maximizing net benefits, in this case, by minimizing losses.

D. When $\frac{\Sigma(b_X - b_Y)}{\Sigma(c_X - c_Y)}$,

only if $C_X = C_Y$ and $b_X \lessgtr b_Y$, then this situation is mathematically undefined and the use of this criterion breaks down. Of course, if $b_X = b_Y$, one is indifferent between the two projects. When $b_X > b_Y$, additional dollars of public funds should be devoted to project X. When $b_X < b_Y$, additional dollars of public funds should be devoted to project Y.

APPENDIX C

COST-EFFECTIVENESS GLOSSARY

COST-EFFECTIVENESS GLOSSARY

ACTIVITY

A program category (q.v.) expresses the purpose of a program; activity is a term which is sometimes used to refer to a way in which the purpose may be accomplished. For example, research and development, standards and regulation, distribution of information, and training of personnel, may be activities applicable to a particular agency program.

BENEFIT-COST RATIO

An economic indicator of efficiency, computed by dividing benefits by costs. Usually, both the annualized benefit stream and the cost stream are discounted so that the ratio reflects efficiency in terms of the present value (q.v.) of future benefits and costs.

BUDGETING

Budgeting is the process of translating planning and programming decisions into specific projected financial plans for relatively short periods of time. Budgets are short-range segments of action programs adopted which set out planned accomplishments and estimate the resources to be applied for the budget periods in order to attain those accomplishments.

CAPITAL COEFFICIENT (CAPITAL-OUTPUT RATIO)

In general, the amount of capital necessary to produce an additional unit of output. In national income analysis, the ratio of the total stock of capital goods (book value of plant and equipment net of depreciation) to the gross value of total production.

COEFFICIENT OF CORRELATION (r)

A measure of how well a linear regression line (q.v) fits the data. This measure, when squared, equals the coefficient of determination (r^2) which is a measure of the total variation (squared deviations from the average) in the dependent variable explained by variation in an independent variable. A high coefficient of determination indicates a good fit for the regression line. Thus a coefficient of correlation of 0.9 indicates that the least-squares regression of the dependent variable on the independent variable accounts for 81 per cent (the coefficient of determination) of the variance in the dependent variable. The limit of the coefficient of determination and of the coefficient of correlation is 1.0.

CORRELATION ANALYSIS

A statistical technique which relates a dependent variable to one or more independent variables in order to determine the closeness of their relationship. When more than one independent variable is involved, the relationship is called multiple correlation.

COST-BENEFIT ANALYSIS
(BENEFIT-COST ANALYSIS)

An analytical approach to solving problems of choice which requires the definition of objective and identification of the alternative that yields the greatest benefits for any given cost, or what amounts to the same thing, that yields a required or chosen amount of benefits for the least cost. The term usually applies to situations in which the alternative outputs can be quantified in dollars. A chief characteristic of cost-benefit analysis is that its aim is to calculate the present value of benefits and costs, subject to specified constraints. See Also: Cost-effectiveness analysis.

COST CURVE

A graphical representation of the relationship of cost to another variable, such as output. It is conventional to construct these curves with costs along the vertical axis and the related variable along the horizontal axis.

COST-EFFECTIVENESS ANALYSIS

An analytical approach to solving problems of choice which requires the definition of objectives, identification of alternative ways of achieving the objective, and identification of the alternative that yields the greatest effectiveness for any given cost, or what amounts to the same thing, that yields a required or chosen degree of effectiveness for the least cost. The term is usually used in situations in which the alternative outputs cannot be easily quantified in dollars. See also: Cost-benefit analysis.

COST ESTIMATING RELATIONSHIP (CER)

Any numerical relationship which is useful in computing estimated costs of materials or activities. These relationships range from simple averages and percentages to complex equations derived by regression analysis (q.v.) which relate cost (dependent variable) to physical and performance characteristics (independent variables). Estimated costs of an aircraft airframe, for example, may be determined by regression analysis to be a function of airframe weight, delivery rates, and speed. The CER shows how values of these independent variables are converted into costs.

CPM AND PERT

CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique) are network analysis models. Each has its own modeling language, but they differ in only one fundamental respect: CPM seeks to determine the expected times of completion of the total project and times of completion of the subprojects of which it is composed. PERT goes further and seeks to estimate variances associated with these expected times of completion.

CRITERIA

Premises on which priorities are established among alternatives in order to measure relative degrees of desirability.

ECONOMIC EFFICIENCY

That mix of alternative factors of production (resources, activities, programs, etc.) which results in maximum outputs, benefits, or utility for a given cost; alternatively, it represents the minimum cost at which a specified level of output can be maintained.

ECONOMIES OF SCALE

Factors that reduce average production costs as the size of a plant increases. Economies of scale may be classified either as (1) internal, resulting from the increased size of an individual firm, or (2) external, resulting from the increased size of an industry as a whole.

EFFECTIVENESS

The performance or output received from an approach or a program. Ideally, it is a quantitative measure which can be used to evaluate the level of performance in relation to some standard, set of criteria, or end objective.

INPUT-OUTPUT (INTERINDUSTRY, OR LEONTIEF) ANALYSIS

A systematic technique for quantitatively analyzing the interdependence of producing and consuming units in an economy. It studies the interrelations among producers as buyers of each others outputs, as users of scarce resources and as sellers to final consumers. Generally, the assumption is that producers have little choice as to factor proportions in the short run and react to demand by changing output rather than price. The technique has been useful for structural analysis and policy guidance, less so for prediction.

LINEAR PROGRAMMING

A deterministic model (q.v.) which assumes linear behavioral relationships and in which an optimal solution is sought (maximizing or minimizing) subject to one or more limiting constraints. Linear programming is used to determine the best or optimum use of resources to achieve a desired result when the limitations on the resources can be expressed by simultaneous linear equations. Every solution has a primal and a dual aspect, that is, a solution maximizing something (primal) also minimizing something (dual). The solution first sought is usually the primal regardless of the objective of the analysis. Linear programs are static; in those instances where change is introduced as a factor the analytic technique used is known as dynamic programming.

MARGINAL UTILITY

The change in total utility due to a one unit change in the number of goods and services consumed, e.g., the additional satisfaction that a purchaser derives from buying an additional unit of a commodity or service. Marginal utility is a psychological rather than an objectively measurable concept.

MODEL

A schematic representation of the relationships that define a situation under study. A model may be mathematical equations, computer programs, or any other type of representation, ranging from verbal statements to physical objects. Models permit the relatively simple manipulation of variables to determine how a process, object, or concept would behave in different situations.

OBJECTIVES

Goals or results that the decision maker wants, or should want, to attain. Hence, the end product or output of a program.

OPPORTUNITY COST

The measurable advantage foregone as a result of the rejection of the next best alternative use of resources. For example, the opportunity costs of assigning auditors to undertake a particular examination are the benefits that would have been achieved by assigning the auditors to the next best alternative audit.

SOCIAL OPPORTUNITY COST DISCOUNT RATE (SOC)

A discount rate used to measure the value to society of the next best alternative uses to which funds employed in a public investment project might otherwise have been put by taxpayers. In a perfectly competitive economy the cost of such funds would be represented by the market rate of interest. Some economists believe that evaluations of proposals for Federal Government projects require that future costs and benefits be discounted at a discount rate which reflects both the social time preference rate (q.v.) and the productivity of funds in private investment.

SPILLOVER

An economy or diseconomy for which no compensation is given (by the beneficiary) or received (by the loser). Spillover is sometimes synonymous with externality and with external economy or external diseconomy.

SYSTEMS ANALYSIS

Systems analysis may be viewed as the search for and evaluation of alternatives which are relevant to defined objectives, based on judgment and, wherever possible, on quantitative methods, with the objective of presenting such evaluations to decision makers for their consideration. In this sense, systems analysis encompasses both cost-benefit (q.v.) and cost-effectiveness analyses (q.v.) and other analyses which may be more limited in scope.

UTILITY

In economics, the real or fancied ability of a good or service to satisfy a human want. Usually synonymous with satisfaction, pleasure, or benefit. See also: Marginal utility.

VARIABLE

A quantity that may increase or decrease without other essential changes.

APPENDIX D

EDUCATION AND LIFETIME EARNINGS: MEN

EDUCATION AND LIFETIME EARNINGS: MEN[1]
(Earnings from age 18 to 64)

HIGHEST GRADE COMPLETED	Earnings at 1960 rates[2]
All education groups	$229,000
Elementary school:	
Less than 8 years	143,000
8 years	184,000
High School:	
1 to 3 years	212,000
4 years	247,000
College:	
1 to 3 years	293,000
4 years	385,000
5 years or more	455,000

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[1] Herman P. Miller: Rich Man, Poor Man, 1964, p. 148.

[2] These are the total amounts that a man with the specified education would earn from age 18 to age 64 if he earned at each year of age the average income that a man of that age and education earned in 1960.

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